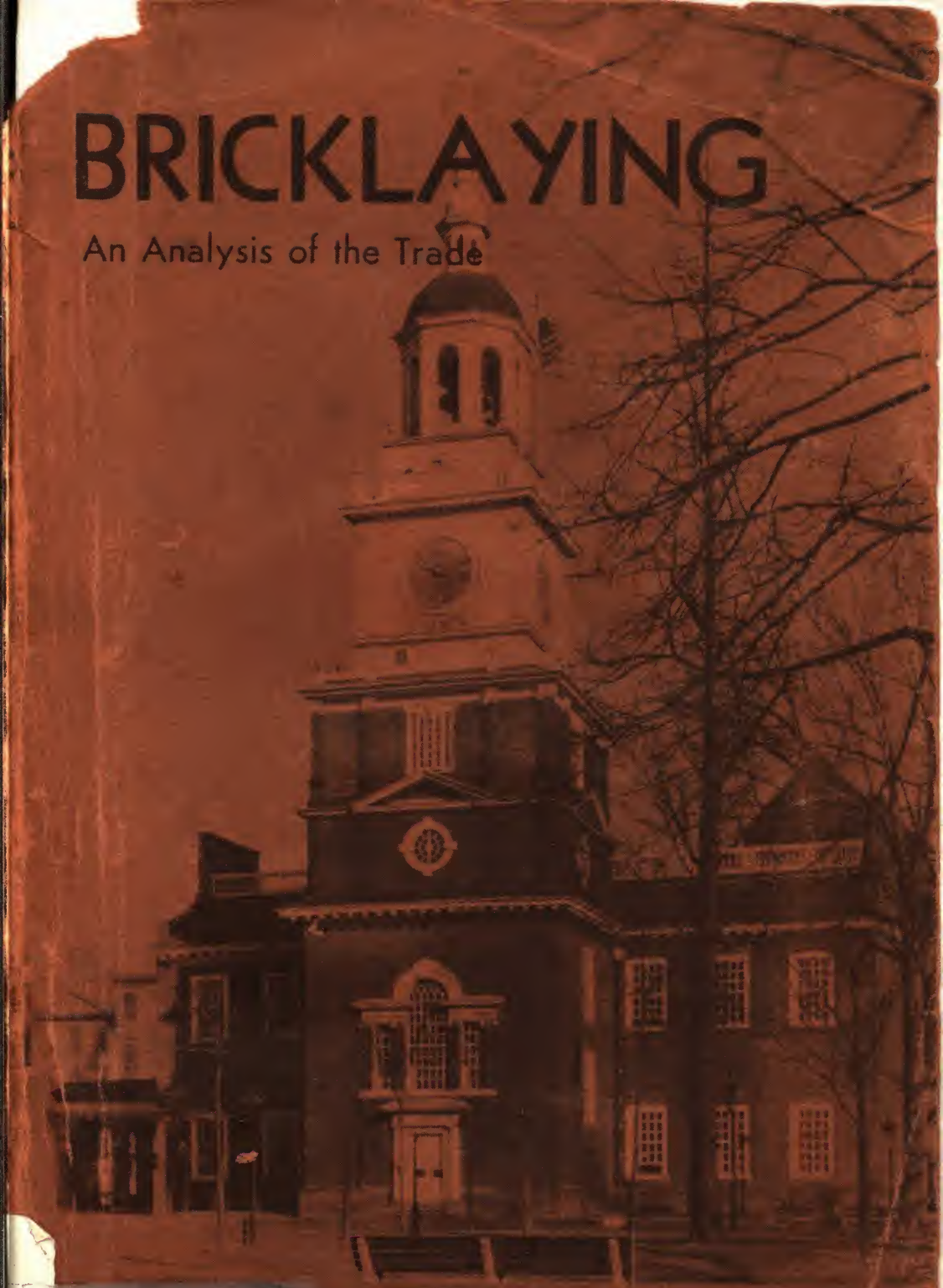
BRICKLAYING

An Analysis of the Trade



FEDERAL SECURITY AGENCY
U. S. OFFICE OF EDUCATION
WASHINGTON, D. C.

Cover illustration. Independence Hall, Philadelphia, Pa. The old State House of the Province of Pennsylvania, more familiarly known as Independence Hall, was built during the years 1732–41, after a plan of Andrew Hamilton.

The front and side brick walls of the hall or tower measure 36 inches at the base and 18 inches at the top. "When this tower was built the mechanics still retained their membership in the 'Guilds.' The work of skilled masons and other building craftsmen now attest after nearly 2 centuries, how faithfully the mechanics performed the labors assigned them."

This building was used by the second and succeeding Continental Congresses, and George Washington on June 16, 1775 accepted his appointment there. There also the Declaration of Independence was adopted on July 4, 1776 and the Articles of Confederation and perpetual union between the States were signed.

The Governor's Palace, Williamsburg, Va., Restoration. Perry, Shaw, & Hepburn, architects.

This building was erected on the north end of the Palace Green on the site of the original palace. The original palace was built in 1705–10, and burned in 1781. It was the home of the Royal Governors of Virginia, and after the Revolution it became the home of Patrick Henry, the first Governor of the State, and also of Thomas Jefferson, his successor. The reconstruction of the building and grounds was based upon careful research through the archives of historical manuscripts in this country and England. The present building, like the original, is constructed of local hand-made, sand-molded brick which are slightly larger than the present standard brick units. It is laid up in Flemish bond with glazed headers.

Vocational Division
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Trade and Industrial Series
No. 60

BRICKLAYING

An Analysis of the Trade of Bricklaying Together With Suggestive Courses of Training for Apprentices and Journeymen Workers

By

GEORGE A. McGARVEY, Agent
Trade and Industrial Education Service

1940

FEDERAL SECURITY AGENCY - - - - - - - - - *Paul V. McNutt, Administrator*
U. S. OFFICE OF EDUCATION - - - - - - - - - - - - - - - - *John W. Studebaker, Commissioner*

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For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - - - - - Price 40 cents

Having served my time as a bricklayer's apprentice and worked at the bricklaying trade in my youth, I am particularly interested in this bulletin—"Bricklaying, An Analysis of the Trade."

To me this publication emphasizes the fact that in a program designed to provide training in a skilled trade, the foreman on the job and the instructor in the school must work together in giving practical training and technical information to the apprentice. Frequently either the practice or the theory of the trade is over-emphasized to the disadvantage of the craftsman, with the result that he is not well balanced in both his skills in the manipulation of materials and tools and in knowledge of the technical aspect of his trade.

This bulletin emphasizes the need of a balanced training program for the apprentice, in which ample opportunity is provided for the practice of the trade and for instruction in trade theory and in the related social and economic subjects necessary to help him to be not only a skillful craftsman but an educated citizen.

John W. Studebaker.

JOHN W. STUDEBAKER
U. S. Commissioner of Education.

FOREWORD

This bulletin, which contains an analysis of the trade of bricklaying and suggestive courses of training for apprentices and journeymen workers, was prepared by George A. McGarvey, Agent for Trade and Industrial Education, United States Office of Education. Although the bulletin is written for the purpose of meeting the needs of instructors of bricklaying apprentices, it will be of interest to employers and employees in the field of masonry construction, architects, engineers; and to manufacturers of and dealers in masonry materials, as well as to those directly concerned with the supervision and instruction of trade classes in vocational schools.

Acknowledgment is made of the assistance received from the Bricklayers, Masons, and Plasterers International Union and from various national trade associations and Government departments, including: The Structural Clay Products Institute; Mason Contractors Association; American Institute of Architects; Portland Cement Association; National Lime Association; the Procurement Division of the Treasury Department; and the Bureau of Standards, United States Department of Commerce. Acknowledgment is also made of assistance given in technical information relating to the trade by H. S. Brightly, formerly Technical Adviser, Indiana Limestone Association; Louis Tirell, bricklaying instructor, Essex County, N. J., Boys Vocational School; Thomas Young, bricklaying instructor, Building Trade School, Detroit, Mich.; J. T. Briscoe, Bricklayers, Masons and Plasterers International Union; H. N. Cooley, State Adviser, Trade and Industrial Education, Harrisburg, Pa.; Richard Shepherd, Superintendent of Construction, J. S. Cornell & Son, Philadelphia, Pa.; Joseph Shisler, formerly instructor of bricklaying, Williamson Trade School, Williamson School, Pa.; Joseph Palmer, Construction Division, United States Army; and Thomas Tenny, bricklaying instructor, Public Schools, Parkersburg, W. Va.

The following brick manufacturers contributed to the bulletin by permitting the taking of photographs of their plants: The Belden Brick Co. and Stark Brick Co., Canton, Ohio; Styles Brick Co., North Haven, Conn.; Baltimore Brick Co., Baltimore, Md.; and Locher and Co., Glasgow, Va.; Yale University, the Williamsburg Restoration, Williamsburg, Va., and Cranbrook School, Cranbrook, Mich.; also permitted the photographing of various buildings under their control for use in this publication.

The author desires to express his appreciation to the following firms for the loan of tools and equipment: Stanley Rule and Level Co., New Britain, Conn.; Goldblatt Tool Co., Kansas City, Mo.; Marshalltown Trowel Co., Marshalltown, Iowa; and W. Rose and Brothers, Sharon Hill, Pa.

The privilege of using illustrations of refractory materials granted by Harbison-Walker Refractories Company, Pittsburgh, Pa., as well as the permission of architects and others to use numerous building illustrations, is also acknowledged. Special acknowledgment is made to the Camden Vocational School, Camden, N. J., for assistance given in preparing the cover for this bulletin.

J. C. WRIGHT,
Assistant U. S. Commissioner for Vocational Education.

CONTENTS

Section III.—COURSES OF INSTRUCTION AND TRAINING

Section IV.—SUGGESTIONS TO INSTRUCTORS

Section V—APPENDIXES

ILLUSTRATIONS

TABLES AND DIAGRAM

Figure 1.—West doorway, Vauter's Church, Essex County, Va.

A fine example of a colonial type of brick doorway which has remained unaltered since it was built in 1719. The classic round top pediment was quite generally used by the early colonial builders for the main entrances of colonial churches. The pilasters, arch, and pediment are built of dark red, rubbed and molded brick of special size. The walls of these early colonial churches were laid up in Flemish bond pattern with glazed headers, using lime putty mortar with buttered joints. The few examples of this classic type of doorway show a workmanship of the highest character.

BRICKLAYING

An Analysis of the Trade

SECTION I

ORGANIZATION AND PLANS FOR APPRENTICE TRAINING

ORGANIZATIONS INTERESTED IN APPRENTICE TRAINING

The construction industry has realized during the past few years that something must be done to induce more boys and young men to enter the building trades. National and State associations of employers have discussed this subject and have suggested steps that might be taken in setting up a program of apprentice training. Various national and international unions have suggested minimum requirements to be included in plans for apprentice training conducted by their locals. Trade journals and the press have given considerable space to the discussion of ways and means for recruiting apprentices for the building trades, pointing out what might be done in the different trades to help solve the problem.

As a result of the interest shown by these various groups, several of the building trades in a number of centers, city and county, have organized training courses for apprentices. A few general contractors in the large cities have also organized and are conducting their own apprentice training programs. In some instances, these training courses have been organized and conducted by either the employer or the employee groups. In the majority of instances, however, they are the result of the combined efforts of both groups working in cooperation with the public school authorities.

FEDERAL TRAINING PLANS

The national vocational education act, providing for the cooperation of the Federal Government with the States in promoting various types of vocational education, was passed in 1917. This act and subsequent acts have resulted in the establishment in the public schools of the States of day and evening classes for apprentices in the various building trades.

The Federal Committee on Apprenticeship of the United States Department of Labor, which is composed of representatives of employees, of employers, and of Government agencies, including the United States Office of Education, the National Youth Administration, and the Division of Labor Standards, was created in 1934 and

in 1937 was made a permanent agency under the United States Department of Labor.

In order to prevent overlapping of the functions and the duties of the United States Office of Education and the Federal Committee on Apprentice Training—the two Federal organizations having to do with promoting the program of apprentice training—these agencies have entered into an agreement under which the United States Office of Education, cooperating with State departments of vocational education, is to be responsible for the apprentice as a student, and the Federal Committee on Apprenticeship, through State apprenticeship councils, confines its activities to the apprentice as an employed worker.

Under this arrangement the functions of the United States Office of Education are to see that the related technical and supplemental instruction needed to make the apprentice a proficient worker is provided, and also that this instruction is coordinated with his job experience.

The function of the Federal Committee on Apprenticeship, on the other hand, is to exercise supervision over the apprentice as a worker. This includes attention to such matters as rates of pay, hours of work, the length of the apprentice-training period, and the ratio of the number of apprentices to the number of journeymen. Attention to the latter precaution is necessary to prevent an overcrowding or shortage of skilled workers.

STATE TRAINING PLANS

Wisconsin was one of the first States to establish a State-wide apprentice program by law. The supervision of apprenticeship carried on under the Industrial Commission in this State covers not only apprentices in the building trades but also in all other trades or occupations. Only trades or occupations in which at least 2 years are required to master the skills, are included in this organized apprentice-training program. Oregon has a State law providing for State-controlled apprentice training.

A number of other States have recently passed legislation providing for State programs of supervision of apprentice training, while still others have set up State apprentice councils within their departments of labor. These councils coordinate the work of the various local trade apprenticeship committees, approve apprenticeship agreements, and promote apprenticeship under accepted standards.

LOCAL TRAINING PLANS

The city unit of organization will, in all probability, be the basis upon which the majority of the new apprentice training programs will be administered. As the number of centers for the training of

apprentices increases in a State, a State apprenticeship council providing for uniform standards, will have to be set up. These minimum standards, which apply to the apprentice as a worker and as a student can be formulated best by a central agency rather than a local group. However, local joint apprenticeship committees should be formed to supervise matters relating to apprenticeship in particular communities. These local joint committees should be made up of an equal number of representatives from the employers and the employees—the two groups particularly concerned with the selection of apprentices for the trade.

DEVELOPING AN APPRENTICE TRAINING PROGRAM

For the successful development of a program of apprentice training, whether the unit of organization is the State, the city, or an indi-

Leopold Photo

Figure 2.—A two-story residence laid up with overburned or clinker brick. Harry Nickelhan, architect.

The mortar joints are left unpointed and an occasional brick is allowed to project to relieve the plain appearance of the wall.

vidual contractor, an apprentice and an instructor must be brought together under the necessary working conditions. The following questions should be answered by those who are responsible for planning and developing a program of apprentice training:

1. What kind of organization is to be set up to guide the training program?
2. How is the training to be supervised?
3. How are apprentices to be selected?
4. How is the instructor to be selected and what should be his qualifications?
5. What subjects are to be included in the training course?

An attempt is made in this chapter and in other chapters of this bulletin, to find the answers to these questions.

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CONTROL OF APPRENTICESHIP TRAINING

Because of the varied interests represented in each of the building trades, it would seem that the administration of apprentice training could best be delegated to a joint committee composed of representatives from all of the interested groups. In a number of the larger cities where the committee plan of administration is actually being used, the joint apprenticeship committee or commission is composed of seven or more representative members. Three members are appointed from the employees' group, three from the employers' organization, and one or more from the public schools.

Figure 3.—Front wing and entrance portico to residence hall at Cranbrook School, Cranbrook, Mich.

Brick is used for columns, railings, and gable end of wing and porch in this building.

A number of plans are followed in selecting joint committees, depending largely upon the local situation. The craft committee is used in some cities where apprentice training has been started in only one trade. The craft committee plan of organization is also used in larger cities where it is possible to set up a joint apprenticeship commission and subcommittees, such as separate craft committees, representing the various building trades.

The Advisory Committee.

Advisory committees are frequently set up even in small cities, where there are only enough building trades to form a group large enough to make it worth while to offer organized training. Such committees cooperate with the public schools in matters pertaining to instruction and training.

Whatever may be the make-up of apprenticeship committees having responsibility for apprenticeship training, whether they be joint or craft committees, either in large or small cities, there is a considerable amount of work for them to do. They attend monthly or bimonthly meetings throughout the year, and in addition, devote considerable time to problems which affect the apprentice both at work and in school. These problems naturally divide themselves into—

1. Those which have to do with the apprentice while at work, including:
    a. Setting up a form of contract agreeable to the apprentice, the employee, and the employer.

b. Determining the scale of wages for the period of training.

c. Seeing that the apprentice is given continuous employment of a progressive character.

d. Settling grievances between employers and apprentices.

2. Those affecting the apprentice and his training, including:

a. Assisting the instructors in determining and in outlining instruction material.

b. Coordinating the work of the apprentice on the job with his instruction in the school.

Among the advantages of having representative committees in control of apprenticeship training, are the following: (*a*) They can give valuable advice and assistance in developing and carrying on training programs; (*b*) those enrolled for training acquire respect for and pride in their jobs, and in the training given, because they know prominent employers help to guide the program and are thus protecting the interest of those in their employ; (*c*) the committee can see that the proper facilities are provided for carrying on this training and that the instruction meets the needs of the apprentice; and (*d*) it can set up trade standards of accomplishment and can demand that all apprentices be trained to meet those standards.

Figure 4.—A bricklaying apprentice laying up a practice job using oversize brick. Detroit Vocational School, Detroit, Mich.

The most successful work in apprenticeship training up to the present time has been carried on in centers where cooperation was secured through the efforts of advisory committees and where each of the interested groups has understood its respective responsibilities.

SECURING APPRENTICES

The primary concern of those responsible for the administration of a program of apprentice training is to induce desirable young men to enter the trade. Because of the demand for workers in various trades and occupations, the employer has had to compete with commercial and industrial concerns for the services of such young men. Both the employer and the employee are vitally concerned in plans which will insure well-qualified apprentices. The contractor, however, is more immediately concerned because he pays the wages and naturally, therefore, is interested in securing competent and well-trained workers.

The worker is interested in securing qualified apprentices because he wants to see trade standards kept up and knows that this is possible only when an adequate number of apprentices are given training under competent journeymen workers.

The Public Schools as a Source of Supply.

The public and private schools constitute a desirable source of supply for apprentices. In attempting to interest a group of school students in apprentice training, the employer should realize, first, that the training of these boys for the 10 or 12 years they have been in school has taken place in an environment entirely different from that in industry. In the second place, he should realize that these youth are probably uninformed as to the methods employed in training apprentices. The employer should keep these things in mind, in discussing apprentice training with boys who are just leaving school, and should attempt to answer such questions as:

1. What does the job pay?
2. How long does it take to learn it?
3. What does the job lead to?

Selling Apprenticeship to the Right Sort of Boy.

The employer, who in the bricklaying trade is the contractor, may point out that industry has set up standards for entrance into the bricklaying trade, just as a school sets up entrance requirements. For example, prospective bricklaying apprentices must have attained a minimum age, have good health, and, in case applications are numerous, must present school records or records of previous experience. The employer may point out that the course of instruction for the apprentice calls for practical experience on the job, supplemented by training in classes organized to teach technical and related subjects; that the course of apprentice training, like the course in school, is divided into period of years, each period being devoted to instruction in a definite phase of the trade; that the instruction is given on the job under competent journeymen and that the training and further experience are gained through actual job practice; and that the examinations given the apprentice are to discover the progress he has made and his ability to do certain jobs according to trade standards.

In general, the employer may explain, the construction trades are classed as assembling trades. This is particularly true of bricklaying, in which partially prepared materials are used and in which initiative as well as skill is required of the craftsman. Among other things, the employer may point out that bricklaying offers a variety of appeal, and is free from the monotony which characterizes certain other industrial occupations.

Because of the demand and the necessity for shelter, which is equaled only by the demand and necessity for food, the bricklaying trade offers assurance of permanent employment. The bricklaying

trade is essential to the well-being and advancement of mankind. The progressive development of the trade or any of the construction trades, no matter to what extent machine-made products are utilized, insures a demand for hand-skill in combining the products used in the bricklaying trade to create a pleasing structure. Bricklaying, moreover, is an outdoor trade, involving active exercise in the open air much of the time, which is conducive to sound health. All these and other advantages may be discussed by the employer in trying to secure recruits for apprentice-training courses.

In addition, he might mention that the very nature of construction work, demanding as it does a combination of particular skills, develops a sense of interdependence and cooperation among the workers. By this interdependence the construction trades promote honesty of workmanship. The bricklayer cannot shirk if he will, for his finished work is the standard by which he must rise or fall.

Figure 5.—Practice work in a vocational school.

An apprentice laying up a fireplace mantel in the Detroit, Mich., Vocational School.

The youth may also be assured that the bricklaying trade is not a local trade, since the skilled craftsman can work anywhere, and that the opportunity for advancement in the trade is unlimited—from apprentice to journeyman, from journeyman to foreman, and from foreman to contractor.

Setting Up a Training Course.

No matter how carefully apprentices have been selected and placed, the final results of the training program will be disappointing unless considerable thought has been given to the planning of the program.

Under the apprentice-training plan commonly followed the apprentice is placed as soon as he starts his apprenticeship under the instruction of a journeyman or foreman. In this way he receives practical training in the manipulative processes of the trade in actual production work. This plan of training has been tried in other industrial lines, and it has been shown that with proper supervision and properly graded jobs the apprentice instructed according to this plan can do a considerable amount of work which will be entirely satisfactory, and at the same time be given training in the trade or occupation. This method of training is advantageous both to the employer and the

apprentice. The employer benefits by reason of the fact that the apprentice becomes a producer as soon as he enters upon his apprenticeship. The apprentice, on the other hand, has the satisfaction of knowing that he is actually getting immediate experience in the practice of his trade.

It is impossible to duplicate many of the actual trade practices when training is given "off the job." This accounts, perhaps, in part for the fact that organized training in the construction industry has not been developed as rapidly as training in the inside trades. Another reason why it is difficult to give organized training in construction work is that instruction must follow the job, which moves from place to place, according to the locality in which building is being carried on. This condition is in contrast to the conditions in "inside" occupations, such as the machinist trade, which are carried on continuously in one place.

Selecting the Instructor.

Only competent journeymen who have learned how to teach should be permitted to instruct apprentices. The loss of time and the reduced production which results when the journeyman or foreman is assigned to give instruction to the apprentice is partially offset by the training the apprentice receives. If the journeyman is not himself a first-class mechanic, or if he is unwilling to train or instruct the apprentice, or if the employer is unwilling that he take the time to instruct, this plan will not work successfully. The employer, the journeyman, and the foreman must be thoroughly in agreement with regard to the purposes if this plan is to produce satisfactory results.

Subjects to be Included in Training Courses.

Under the apprentice-training plan commonly followed, a definite amount of classroom instruction—usually from 4 to 8 hours a week—is given in general vocational subjects, job technical knowledge, and in auxiliary information related to the trade. The plan to be followed in giving this type of instruction is usually worked out in cooperation with local school authorities, who are authorized under the provisions of State vocational education acts to offer part-time instruction for employed youth. Some of the time allotted to related instruction may be devoted to training the apprentice in jobs in which he is unable to secure training under employment conditions. Training in these jobs, of course, must be given on an exercise basis or in the form of practice jobs.

COOPERATION WITH PUBLIC VOCATIONAL SCHOOLS ESSENTIAL

As has already been pointed out, schools are equipped to give only a part of the instruction which should be provided for bricklaying apprentices. Technical and related subjects, including general voca-

tional subjects can be taught better, of course, in a school than on the job. Adequate job training, on the other hand, can best be given an apprentice on the job under the supervision of a journeyman instructor. Where job training cannot be given in this way, schools can offer a fair amount of preliminary training, especially on a number of elementary jobs, through the use of the so-called "practice jobs" method.

Apprentices can be partially trained in the full-time day trade school. In some instances, agreements have been entered into between the employer and the school, whereby a boy who has received

Figure 6.—The Wren Building at William and Mary College, Williamsburg, Va.

The original building was designed by Sir Christopher Wren, of London. This building has been restored and is still used as an administration and assembly hall for the college.

partial training in a vocational school will be given some credit on his apprenticeship period for the time he has spent in school.

FEDERAL AND STATE FUNDS AVAILABLE FOR APPRENTICE TRAINING

Under the national vocational education acts, Federal grants are available to the States for the specific purpose of carrying on vocational education. These funds, moreover, are supplemented by State or local funds. Those in charge of apprentice training should bear in mind, therefore, that they can secure help in training programs from the public schools in their city or their State. As previously pointed out, every State has set up a State board for vocational education, and has appointed a State director for vocational education, as well as a supervisor of trade and industrial education. Many of the larger cities, also, have appointed local city supervisors of industrial education. Those who are responsible for the establishment of apprentice-training classes for bricklaying apprentices, therefore, should get in touch with city superintendents of public instruction or local city su-

pervisors and ascertain from them what assistance can be secured in organizing classes for apprentices in the public schools, whether local or State funds are available to help pay for an instructor in organized classes, what steps would be necessary to secure this instruction and to set up organized classes, and also what facilities are available in the schools for conducting such classes.

Those who are interested in apprentice training, also, should bear in mind that the national vocational education acts provide Federal aid to the States for promoting training for journeymen selected to give instruction to apprentices. The journeyman will be particularly interested in this training as it will be necessary wherever courses are established to use journeymen as instructors. Information as to where he can get such training at public expense, which may be obtained from the State Director for Vocational Education, is of interest to the journeyman looking forward to entering the field of trade teaching.

SUPERVISION OF APPRENTICE COURSES

Supervision of apprentices may be carried out in several different ways. For instance, where the apprentice group is large enough to justify it a full-time coordinator may be employed to supervise the group. If the group is small, the instructor may be responsible for both the teaching and supervising work. When this plan is followed the instructor should devote about one-fourth of his time to supervising and three-fourths to instructing. This plan can be followed only where the job instruction is given on the job under a journeyman, and the supplementary technical instruction in a class organized for this purpose.

CONCLUSION

A representative committee is the most desirable group to administer apprentice training. As has been pointed out, the interests in the construction industry are so varied that the success of a training program for workers in any phase of the industry depends on the cooperation of all groups interested. This cooperation is assured when a representative craft or advisory committee is appointed to assist in the program.

The picture of the bricklaying trade must be presented to the prospective apprentice in such a way as to convince him that there are definite possibilities for advancement and achievement in the construction field. Training for apprentices must be organized and given systematically, preferably on the job, and must be supplemented by class instruction in an organized school. Employers, employees, and the school should bear in mind that they may secure assistance from the State in carrying on instruction and training.

Probably the greatest difficulty in the way of effective cooperation between the parties in interest in apprentice training is the possibility of a misunderstanding of each other's problems. This difficulty may

Figure 7.—A group of "beehive" type kilns in a large brick plant.

be avoided, however, if the interested groups—employers, employees, and school officers—come together in conferences, either as members of craft or trade advisory committees or in other capacities. The value of such cooperation has already been demonstrated in numerous localities.

SECTION II

CLASSIFIED ANALYSIS OF THE BRICKLAYING TRADE

HOW THE JOB ANALYSIS IS MADE

As a preliminary step in outlining suggestive courses of instruction in bricklaying, a classified analysis has been made of the jobs common to the trade. This analysis is not in any sense a course of study or plan of instruction; it is merely an inventory of many of the jobs in the trade, and of the technical information that goes with each job. This technical information and manipulative experience, listed in the trade analysis, should be acquired by the apprentice during his apprenticeship period.

When the jobs listed in the classified inventory have been properly grouped and outlined, they can be used as the bases for courses of instruction to meet special training conditions, such as courses for apprentices set up as part-time trade extension, and dull-season classes. The jobs included in the analysis can be used also as the basis for training courses in day trade schools or for advanced courses offered to journeymen workers.

Since the analysis is a classified inventory of the specific content of the trade from which material for training courses can be drawn, it is necessary that the instructor have an intelligent understanding of the method of making and using the analysis, in order that he may be able to assemble material for courses of instruction.

It is not uncommon for one who is skilled in his trade to lack the ability to tell some one else what the various jobs in his trade are, and what information is necessary to carry on each of these jobs. The journeyman worker acquires his skill and knowledge through a long training period, and it is difficult for him to explain the various steps in his trade. Many things which to him have become "matters of habit" he does not consider worth mentioning, forgetting that these very things had to be acquired through repetitive training in the early period of his apprenticeship. For these and other similar reasons, it is almost impossible for a tradesman working by himself to list the jobs and related information that constitute the knowledge and practice of his trade. On the other hand, one thoroughly versed in the technique of making such an analysis, but not himself a competent workman, does not possess the knowledge and experience necessary to make a trade analysis. However, the two working together, the tradesman

who understands his trade and the educator who knows the technique of making an analysis, can produce a comprehensive outline covering the main points in any trade or occupation.

Scope of the Analysis.

The analysis of the bricklayer's trade should cover the trade content with which the average journeyman is familiar. Since the specially skilled bricklayers of the future must come from the ranks of the trained apprentices, the job analysis presented in this publication has been expanded to include not only an inventory of the knowledge and skill which the apprentice should acquire during his apprenticeship,

Leopold Photo

Figure 8.—A building laid up in Flemish bond at Johns Hopkins University. Palmer and Landin, architects.

Cut stone is used as a trim in the base and band course, also as key stones in the arches over windows in the central wing.

but also a certain amount of information of a broader nature, which he should possess.

For the purpose of this bulletin the outline of the bricklaying job is set up under two general divisions:

1. A classified analysis of the trade, and
2. General vocational information.

Limits of the Analysis.

The analysis is confined entirely to the bricklaying trade, no attempt being made to deal with the content of any other form of training that might be included in a general training course for apprentices, such as general educational subjects. It should not be implied from this, however, that civic or general training should not be included in a course of instruction for apprentices.

A CLASSIFIED ANALYSIS OF THE TRADE

In order to secure a systematic arrangement of the job analysis, certain predetermined classification headings are used, as follows:

BLOCK: The block, which is the main classification division of the analysis, is made up of a group of jobs having learning difficulties of the same general nature. These learning difficulties are of varying degrees, appearing in their simplest form in the first job and increasing with every succeeding job. The job analysis here presented is based upon: (1) The nature of the finished job, (2) the kinds of materials used, and (3) the combination of materials used and the variety of jobs occurring in a finished unit of construction. However, other forms of classification may be used. For example, an analysis might be based entirely upon the operations followed or the materials used in the trade. The present analysis is divided into five blocks covering various phases of the bricklayer's job:

Figure 9.—A bungalow type of brick house.

Overburned and irregular-shaped brick are used in laying up the walls. The brick are laid in a rough manner without regard to straight bed courses. Brick are allowed to project from the wall, producing an interesting rough textured surface.

Block–BL–I.—Semifinished work.
Block–BL–II.—Finished work.
Block–BL–III.—Setting of terra cotta and cut stone trim.
Block–BL–IV.—Refractory materials.
Block–BL–V.—Construction jobs.

In carrying out the jobs listed in Block I the apprentice acquires the necessary skill in laying common brick and doing simple jobs in which it is not necessary to pay much attention to the finished appearance of the work. This block includes the jobs commonly encountered in laying up inside walls in which the surface is later to be covered or jobs in which the appearance does not have to meet the standards required for finished work.

After acquiring the knowledge and skill necessary for carrying out the jobs listed in Block I, the apprentice repeats many of these jobs in doing the jobs included in Block II. In doing the jobs included in Block II, moreover, he must meet the standards set up for finished brick work. To do such work it is necessary that the apprentice acquire skill in manipulation and the ability to use materials on jobs of a finished character.

Having acquired skill in handling common or face brick, hollow tile, and other backing-up materials in connection with the jobs included under Blocks–BL–I and II, the apprentice should, in doing the jobs included in Block–BL–III, learn to handle other materials requiring special methods of laying and finishing, such as setting and pointing up architectural terra cotta and cut stone trim.

In doing the jobs included under Block–BL–IV, the apprentice will acquire the knowledge and skill necessary to handle refractory materials. Additional difficulties will be encountered in learning to handle this material because of the variety of shapes and sizes and the methods used in laying it up.

Finally, in doing the construction jobs included in Block–BL–V, the apprentice has an opportunity to use the knowledge and skill he has acquired in carrying out the jobs listed in the four previous blocks and to learn how to use in combination the various materials common to the trade.

JOB CLASSIFICATION

The information which should be available in giving instruction in various bricklaying jobs is discussed under the following headings:

The Job.
1. Type job specifications.
2. Type jobs.

Objective.

Trade technical knowledge.
1. Drawing, science, mathematics.

Auxiliary information.
1. Recognition of stock, working properties, and trade terms.
2. Care of tools and equipment.
3. Safety.

Training progression.
1. Repetitive training.
2. Instruction required.

The information which should be available under each of these headings is presented in chart form on pages 23 to 64.

The Job.

Under the heading "Job" are listed, in the order of their "doing" difficulty, the jobs common to the trade of bricklaying.

These jobs are listed in the serial order indicated by the numbers on the margin of the first column. Thus, the easiest job from the standpoint of learning is given first and the more difficult jobs follow. With each type job or series of type jobs listed in the first column is included the technical knowledge and auxiliary information which workers in the particular job or group of jobs should possess.

Job specification.—The job specification in any checking level describes the kind of job which should be selected as a basis for instruction. The specifications do not refer to any specific job. For example, Job Specification 2, under Block BL–I, refers to the laying up of common brick between vertical uprights on work requiring a semifinished appearance. It makes no difference what kind of ma-

Lock Photo

Figure 10.—A modern fireproof brick house built largely of clay products.

The walls are laid up in common bond with Flemish headers and stretchers every fifth course. The floor and partitions are of hollow reinforced tile and the roof is covered with shingle tile.

terial the uprights are made of or upon what type of wall the uprights are placed.

If the completed job has a semifinished appearance and the uprights are vertical and not too far apart, the conditions of the type job specification will be complied with.

Type jobs.—Included under the type job specification are one or more actual jobs which meet closely the specification set up for a particular checking level. It should be understood, however, that there are many other jobs in the trade which would represent the type job specification equally well. As a matter of fact the type job specifications represent a group of jobs, any one of which could be used for the purpose of instruction.

Objective.

The column headed "Objective" contains a simple statement of the things the learner should be able to do after receiving instruction on the particular group of jobs under the specification headings. In

other words, the objective is a statement of the additional practice and knowledge the apprentice will acquire by doing a sufficient number of jobs in a particular checking level. For instance, when an apprentice has completed the job of backing up between uprights in a short space to the satisfaction of the instructor or foreman, he should have attained the learning objective of the particular checking level. In some cases it may be necessary for the apprentice to repeat the job a number of times in order to acquire the necessary experience designated in the job objective.

Trade Technical Knowledge.

Under the general heading, "Trade technical knowledge," the technical facts relating to a particular job or series of jobs are included. For the purpose of this analysis the technical knowledge or information is included under the subheadings "drawing," "science," and "mathematics."

Drawing.—Under the column headed "drawing" there is given with each group of type job specifications the facts relating to drawing that it is well for the apprentice to possess in order to carry on the jobs included under these specifications. It should be understood, however, that the term "drawing" as used in this analysis includes the making of a sketch, the reading of a drawing, or the use of a combination of representative lines on paper or other material in order to impart or secure information. It is not assumed that the bricklayer is in any sense a draftsman, or that he is expected to acquire any special technique in making drawings or sketches. The training necessary to give the apprentice further ability in making and reading drawings is discussed in the section devoted to general vocational information on page 151.

Science.—The scientific facts affecting the procedure on the job are noted in the column headed "science." For example, it is a fact that ordinary cement or lime mortar will not stand heat as will fire clay. This fact is taken into consideration in the laying of refractory materials. No attempt is made to give an explanation of scientific or technical facts as they appear in the analysis. They are stated in simple language, and are given only where they affect job procedure and to answer the questions which the apprentice may ask regarding a particular process. Attention is called, however, to the fact that it may be well to give a certain amount of applied chemistry or physics in a general vocational course for the purpose of helping the apprentice in understanding better the practices of this trade.

Mathematics.—Accompanying each type job specification is a statement of the mathematical problems which the apprentice must be able to solve in carrying on one or more of the jobs. These problems are stated in mathematical terms, and include a suggestion as to the method of solving them. The special devices which might be

used in working these problems are also presented. For instance, it is brought out that in determining linear measurements on vertical heights, a story pole is used for laying off distances such as sill heights and window openings and that in addition the story pole is marked off according to definite units of measurement, consisting usually of a brick and mortar joint. Although distance is not expressed in feet and inches, the unit of measurement in this instance is the "course," and the apprentice must make use of this device in laying out his work. In case the apprentice has access to a brick mason's spacing rule, on which the heights of various courses of brick and mortar joints have been worked out for various distances, it would be well for the instructor to discuss the use of this rule in laying out courses of different heights. The length of this zigzag mason's rule is usually 6 feet.

Leopold Photo

Figure 11.—A county building laid up with brick and cut stone. L. H. Fowler, architect.

Molded brick are used in the water table course. The band course consists of four courses of headers. The walls are laid up in Flemish bond and the jack arches over the window openings are laid up with gaged and rubbed brick.

These statements of mathematical facts are not made under any special classification heading, such as arithmetic, algebra, or geometry. Geometrical facts, for instance, can be stated and problems worked out without giving the apprentice a formal course of instruction in geometry.

As set up in the analysis, any method of measuring or determining the relation of lines or surfaces to each other, such as lines or surfaces running parallel or intersecting are regarded as mathematical problems even though some of the operations involved in solving these problems may seem extremely simple.

Auxiliary Information.

In addition to the trade technical knowledge, consisting of drawing, science, and mathematics, which he must secure while doing a particular job, the apprentice must have an understanding of other

related information which concerns the materials of the trade and the tools and equipment he is using. This information is classified in the job analysis as "Auxiliary information," and for the purpose of presenting it on the analysis charts it is classified under the subheadings "Recognition of stock" and "Care of tools."

Recognition of stock.—The apprentice should be able to recognize the different materials common to the trade of bricklaying and the particular shapes or forms of these materials. For example, a bricklayer who knows the different kinds of brick will not make the mistake in laying up face brick, of confusing face brick and common brick. Although the apprentice acquires much of the information regarding bricklaying materials without any particular instruction, he must secure it in some way. The information which the apprentice should have on the materials with which he must work is indicated under the heading, "Recognition of stock." Full details concerning this information are not given, because it is assumed that the instructor or journeyman under whose charge the apprentice is placed will be familiar with the information.

Working properties.—The procedure followed on the bricklaying job must sometimes be changed to meet the peculiar properties of the materials used. For example, glazed brick requires a different method of cutting than common brick. The glazed brick must be cut with considerable care in order to avoid shattering the glazed surface, and thus marring the appearance of the finished job. A knowledge of how to cut glazed brick and of the tools required for this purpose should be possessed by the apprentice when he has occasion to use this material.

Trade terms.—In the column headed "Trade terms" are listed the more common terms used in connection with each type job specification, including, in some instances, the names of materials or operations used in the trade, as well as the terms peculiarly adapted to the trade. These trade terms are included in the analysis so that the instructor will be sure to inform the apprentice of their meaning. Where special local terms are used the instructor must, of course, include these in his instruction.

Care of tools and equipment.—Under this heading there is included information regarding the proper care of tools and equipment, a knowledge of which every apprentice should possess. For this reason very little information on the care of tools and equipment is needed by the apprentice. The tools used in bricklaying are few and much of the equipment is in the form of scaffolds, wheel barrows, and the like, which are furnished and kept in repair by the employer. However, the column headed "Care of Tools and Equipment" has been

included as a part of the analysis chart in order that it may conform with the usual analysis layout.

Safety.—Wherever the type job specifications call for work which involves safety precautions of any kind on the part of the worker or others, these precautions are indicated on the analysis. It is assumed that a competent instructor will have a knowledge of the ordinary hazards of the trade and will instruct the apprentice in the precautions to be taken to protect himself against these hazards. For example, the specifications on type jobs calling for work on outside scaffold call attention to the danger of dropping materials from the scaffold, to the care which should be taken against overloading, and to the importance of seeing that the guard rail required is in place.

Training Progression.

After the learner has received instruction on any particular job he must be given ample opportunity to practice what he has been taught. It is through repetitive practice that he gradually acquires speed and confidence.

For example, the learner who works on the second type job included under Block–BL–I is afforded an opportunity to secure additional practice in the procedure followed in doing the first type job. The same statement holds true also for practically any of the jobs included under each block.

By being given an opportunity to carry on the series of jobs indicated in this job analysis, the learner will secure invaluable cumulative training and experience. In doing the jobs included under Block–V—the last block in the analysis—the learner or apprentice makes use of the knowledge acquired in doing each job listed in the previous blocks.

Charts.

As previously indicated, the blocks into which the trade of bricklaying has been divided for the purpose of the job analysis described in this bulletin have been arranged for convenience in chart form. The jobs included in Blocks I and II have been analyzed with respect to their nature and the difficulty in doing them; the jobs included under Blocks III and IV, on the basis of the kinds of materials used; and the jobs included under Block V, with respect to the combination of materials used and the variety of these jobs occurring in finished units of construction work.

The job analysis outlined in the charts is presented by "blocks," as follows:

Block BL–I.—Jobs calling for semifinished work.

Block BL–II.—Jobs calling for finished work.

Block BL–III.—Jobs calling for setting of architectural terra cotta and cut stone trim.

Block BL–IV.—Jobs calling for the setting of refractory materials.

Block BL–V.—Construction jobs in bricklaying calling for the laying out and laying up of brick, using a variety of materials.

Leopold Photo

Figure 12.—A southern colonial type of brick house laid up in common bond.

The painted brick walls are laid up with common hard burned brick.

BRICKLAYING

BLOCK—BL–I.—BLOCK BASE: JOBS CALLING FOR SEMIFINISHED WORK

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
1. *Job specification.*—Backing up with common brick, using common bond against a vertical wall between established vertical ends not over the length of 6 bricks. Surface appearance not important. Working from inside of wall. Mortar ready mixed. (NOTE.—The term common brick refers to burned clay or shale brick. Other precast materials may be used but should be called by their correct names, such as lime brick or precast cement brick or the like.) *Type jobs* *a.* Backing up the face of an 8-inch wall between window jambs, using common brick. *b.* Backing up as above, between door jambs, using common brick. *c.* Backing the face of a wall between openings not over 6 feet, using precast brick or brick size.	Some ability in spreading mortar and placing brick on inside tier of wall, between vertical ends, using running bond. Ability in arranging courses so as to come out even and level with top of face tier.	.....	Mortar dries out when exposed to air. The larger the surface exposed the quicker the drying. Dry brick absorb water from mortar. Water evaporates more on a hot day than on a cold day. Frozen mortar expands and will not set. Frozen mortar will not stick to brick. Mortar made with hot sand and hot water will often set before freezing. Warm brick cause mortar to set quicker. Color of brick varies depending upon chemical composition of clay or shale in burned brick. Brick vary as to the amount of water they will absorb. Compression or tensile strength varies depending on amount of burning of clay or shale brick or composition of cast bri k.	Eye estimation of length in brick units. Eye estimation of mortar in terms of number of brick in bed course. Determining number of brick needed by laying in wall dry. Standard size of common brick approximately 2¼ x 3¾ x 8 inches.	Recognition of stock: Ability to recognize common brick, cement or sand lime brick. Recognition of mortar in the right condition. Trade terms: Backing, cutting off, spreading, running, bond, header, stretcher, trowel, mortar board, brick hammer, common brick, salmon brick, sand lime brick, hard burned brick, overburned brick, cement and cinder brick, sill, joists, weather strip, course, bed joint, vertical joint, cross-joint, jamb compression and tensile strength.	Care of tools: Cleaning trowel at end of job. Safety: Lime in mortar burns the skin. Keep mortar from trowel handle and ferrule.	*Instruction required: How to pick up and spread mortar. How to space and lay up brick on an inside wall between vertical uprights so that course will come out level with top of face wall.*

BLOCK–BL–I.—*Block Base: Jobs Calling for Semifinished Work*—Continued

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
2. *Job specification.*—Backing up an 8-inch wall with common brick, hollow tile, or precast blocks, using common bond against a vertical wall between established ends for any length over 6 brick, surface appearance of finished wall is not important. *Type jobs* *a.* Backing up an 8-inch wall between 2 door frames. *b.* Backing up between 2 window frames. *c.* Backing up between openings using precast brick or blocks. *d.* Backing up between opening using structural hollow tile.	Improved ability in spreading mortar and some ability in picking up the right amount of mortar for two or more brick and laying up a left or right hand lead against a vertical guide and filling in wall between leads to a line bringing top course parallel to face course.	----------	Water will soften and wash out mortar that has not set. Brick will absorb water. Headers are used to equalize load. Usually placed every sixth course in wall laid up with running bond.	Linear measurement to one-eighth inch. Device used, a marked stick on which height of brick and mortar bed have been marked. Unit of measurement is thickenss of brick and bed. Running a series of parallel lines. Device used, line stretched between steps in lead.	Recognition of stock: Proper methods of protecting work from rain. Trade terms: Lead, line, line block, line pin.	Care of tools: Keep line wound up and dry when not in use.	Repetitive training in picking up and spreading mortar, spacing brick and laying up brick on inside wall between vertical uprights. *Instruction required: How to lay up a left or right hand lead against a vertical guide. How to lay up wall between leads to a line and how to bring the top course parallel to the face course.*
3. *Job specification.*—Backing up with common brick, using common bond against a vertical wall between an established end and a corner wall of any length. Sur-	Ability in spreading mortar and estimating amount of mortar for 2 or 3 brick and knowing how to lay up an inside return lead against a face	----------	Too much water in mortar will "bleed" out causing stain on wall.	----------	Recognition of stock: some ability in recognizing suitable mortar for a particular job.	----------	Repetitive training in spreading mortar, estimating amount of mortar to use, placing brick, cutting to length on inside tier of wall between vertical ends, using com-

face appearance not important. *Type jobs* *a.* Backing up an 8-inch wall between a door jamb and an inside corner. *b.* Backing up an 8-inch wall between a window frame and inside corner.	tier and be able to bring top courses parallel to face tier.						mon bond. Laying up a left or right hand lead against a vertical guide, laying up wall between leads to a line, and bringing the top course parallel to the face. *Instruction required: How to lay up an inside return lead against face tier any length.*
4. *Job specification.*—Filling in with common brick between two vertical walls, using shove joint. *Type jobs* *a.* Filling in on a 13-inch wall between face tiers. *b.* Filling in between joists and around jambs.	Ability to make a shove joint and not crowd either wall.	.....	Wood decays when subjected to dampness. Mortar beds too deeply furrowed are not water tight. End joints admit water if not properly filled.	Thickness of wall usually determined by a number of units, each unit consisting of the width of brick and mortar joint.	Trade terms: Shove joint, filling in, crowding the line, pick and dip method, grout.	.....	Repetitive training in spreading mortar and placing brick on inside walls. *Instruction required: How to make a shove joint without crowding either wall. How to fill bed and end joint properly.*
5. *Job specification.*—laying up an inside tier and filling in on a 13-inch wall, header high, using common bond between established vertical jambs or frames. *Type jobs* *a.* Laying up and filling in between window frames. *b.* Laying up and filling in between a window frame and door frame.	Ability to properly space, lay up and plumb, an inside tier of a 13-inch wall and fill in between tiers to header course height.	.....	.....	Estimating right angle and estimating equal bricks by eye measurement.	Trade terms: Tier, header, stretcher.	.....	Repetitive training in spreading mortar, placing brick on inside tier of wall between vertical ends. Laying up a left or right hand lead against a vertical guide and laying up wall between leads to a line and filling in between tiers, not crowding either wall. *Instruction required: How to properly space and bond inside tiers on a 13-inch wall.*

BLOCK–BL–I.—*Block Base: Jobs Calling for Semifinished Work*—Continued

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
6. *Job specification.*—Laying up an inside tier, filling in and placing inside header course on 13-inch wall between vertical jamb or frame and inside corner for any distance. *Type jobs* *a.* Laying up an inside tier and filling in on a 13-inch wall between corners and window frame of first story.	Ability to lay up and plumb inside corner leads and fill in between tiers and lay header course at proper height on 13-inch wall for any distance.	.....	A spirit level or plumb is constructed on the principle that a bubble of air will rise to the highest point in a curved glass tube. If blade of square is held plumb, the tongue will be level.	When one side of a right angle is horizontal, the other must be vertical.	Trade terms: Level, plumb; brick hammer, trig.	Care of tools: The level is dropped or allowed to warp, it must be adjusted. Keep level protected from weather. Care in sharpening blade of hammer.	If repetitive training in placing brick on inside tier of wall between vertical ends. Laying up left or right hand leads against vertical guides and laying up wall to line between leads, filling in between tiers without crowding the wall. *Instructions required; How to lay up leads and plumb inside corners, and how to lay a header course on an inside tier at proper height on a 13-inch wall of any length.*
7. *Job specification.*—Laying up an 8-inch division wall, common bond without opening, semifinish. *Type jobs* *a.* Laying up an 8-inch basement partition wall without openings. *b.* Laying up an 8-inch curtain wall.	Ability to properly join division wall to main wall, make bed joints of even thickness, gage properly with story pole, place header courses at proper height, point up with struck or weathered joint, all up to standard of semifinished work.	.....	.....	Eye comparison of length. Linear measurement. Determination of width of wall using brick unit.	Trade terms: Story pole, point up, struck joint, weather joint, toothed wall, recessed wall, curtain wall, panel wall, enclosure wall.	.....	Repetitive training in spreading mortar, laying up leads and laying to line, placing brick, cutting to length between vertical ends. *Instruction required; How to properly join a division wall to a main wall, how to make bed and vertical joints of even thickness, how to gage with a story pole, how to place header courses at proper heights, and how to point up with struck or weathered joint all up to standard of semifinished work.*

8. *Job specification.*—Building around bottom and side of a right right-angled opening in an 8-inch semi-finished wall using common bond, common brick. *Type jobs* *a.* Laying up an 8-inch division wall with window opening. *b.* Laying up an 8-inch inside wall with door opening, no frame.	Ability to lay a rowlock sill with buttered joints and build around sides of opening plumb and place anchor blocks where indicated.	----------	Wood expands when wet and shrinks when dry.	Determining pitch in inches from given inch per foot.	Trade terms: Rowlock sill, anchor block.	----------	Repetitive training in spreading mortar, placing brick, cutting to length, laying up leads and laying to line. Placing brick, cutting to length between vertical ends and joining a division wall and a main wall, gaging with a story pole and making struck or weathered joint up to standard of semi-finished work. *Instruction required: How to lay a rowlock sill with buttered joint, how to build around sides of the opening plumb, and how to place anchor blocks where indicated.*
9. *Job specification.*—Building over a right-angled opening using an iron lintel. *Type jobs* *a.* Laying up an 8-inch division wall with door or window opening using stretcher course not over 4 feet in width. *b.* Laying up a division wall with opening having "soldier" lintel.	Ability to space courses in a given height by means of story pole. Place and level lintel iron and space and lay wall over small opening in an 8-inch inside wall.	Ability to check up the setting of frame by others and reading dimension sketch attached to tag of frame (if any).	The same amount of iron in the shape of an angle iron or channel iron will spring less than when in the shape of a flat piece.	Ability to use linear measurement to accuracy of one-eighth inch.	Trade terms: Angle iron; channel iron, soffit, stretcher course. Soldier course pier.	Safety: Use support if necessary to hold bricks in lintel until top course is laid over arch.	Repetitive training in spreading mortar, placing brick, cutting to length on inside wall between vertical ends, using common bond. Laying up a left or right hand lead against a vertical guide, laying up wall between leads to a line and bringing top course parallel to the face course. Joining a division wall to a main wall, placing anchor blocks where indicated. *Instruction required: How to space courses for a given height using a story pole, how to place and level a single or double lintel iron and how to space and lay a wall over a small opening (not over 4 feet) in an 8-inch inside wall.*

BLOCK–BL–1.—*Block Base: Jobs Calling for Semifinished Work*—Continued

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
10. *Job specification.*—Laying up an 8-inch vertical pier running bond, semifinish, square corners. *Type jobs* *a.* A porch pier two bricks square weathered joint. *b.* A solid basement pier under 8 feet in height, square or rectangular in shape.	Ability to lay up a vertical wall, square or rectangular in place using common bond, semifinish, square corners.	Piers are usually located on plans (1) from outside wall to center of pier, (2) from center to center of piers.	Piers are designed to carry a load. The ratio of the thickness to height of pier should not be over 10. The smaller the ratio the greater the compression strength. Voids in bed or end joints weaken pier.	If two intersecting walls are vertical, the corner must be plumb, Determining a right angle by 6–8–10 method or multiple thereof. Dividing brick into halves and quarters by eye estimation.	Trade Terms: Pier, square, weathered joint, round jointer, concave joint.		Repetitive training in spreading mortar, for two or more bricks, placing brick, using running bond, cutting brick to any length, making bed and vertical joints of even thickness, plumbing up corners, and pointing up with struck or weathered joint. *Instruction required* *How to lay up square corners on a pier and finish joints with jointing tool.*
11. *Job specification.*—Laying up an 8-inch wall, common bond, semifinished, square corners, and building around wood or iron fittings set permanently in the wall. *Type jobs* *a.* Partition wall with inside or outside corner with openings. *b.* Partition wall with door opening having iron hinges set on jamb.	Ability to lay up return leads properly bonded on 8-inch semifinished wall, using common bond, and properly anchor and build around wood or iron fittings.	Iron fittings to be anchored in wall are usually indicated on drawing by dotted lines.			Iron hinges, jamb blocks, anchor irons, nailing pieces, thimbles, pipes, ash doors, sleeves.		Repetitive training in spreading mortar, for two or more bricks, placing brick, using running bond, arranging courses so as to come out even and level with top lead, laying up wall between leads to a line, laying up and plumbing inside corners, cutting brick to any length (joining a division wall to a main wall), making bed and vertical joints of even thickness, placing header courses at proper heights, pointing up with struck or weathered joint, lay-

							ing a rowlock sill with buttered joints, building around sides of openings, spacing courses for a given height using story pole, placing and leveling an angle iron, spacing and laying wall over a small opening (not over 4 feet) and laying up an inside and outside square corner up to semifinished standards. *Instruction required: How to lay up a square end in an 8-inch wall and how to properly anchor and build around wood or iron fittings.*
12. *Job specification.*—Laying up a wall, common bond, semifinished, square corners with projecting or receding courses. *Type jobs* *a.* Laying up footing for 12-inch pier. *b.* Laying up footing for an 8-inch wall. *c.* Corbeling out on an 8-inch wall.	Ability to lay up walls with projecting or receding courses, properly bonded together, on semifinished work.	----------	The total load consists of weight of pier or wall, the footing and load to be carried.	Constructing parallel lines by means of a line. A circle is divided into degrees. Angles are measured in degrees.	Stock recognition: Recognize lime-cement mortar in proper working conditions. Trade terms: Corbeling, receding, projecting, bearing, plates, offset, degrees, circle, total load, set back.	----------	Repetitive training in spreading mortar placing brick, cutting to length, arranging courses so as to come out even and level with top, laying up left or right hand leads, laying up wall between leads to a line, cutting brick to any length, making bed and vertical joints of even thickness, placing header courses at proper heights, pointing up with struck or weathered joint (laying a rowlock sill with buttered joints, building around sides), laying up inside and outside square corners. *Instruction required How to lay up walls with projecting or receding courses bonded together on semi finished inside work.*

BLOCK–BL–I.—*Block Base: Jobs Calling for Semifinished Work*—Continued

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
13. *Job specification.*—Laying up an 8-inch intersecting wall with common bond, semifinished work. *Type jobs* Laying up an 8-inch *a.* wall with built-in 8-inch wall. Laying up a 4-inch *b.* by 16-inch pilaster on both sides of an 8-inch wall.	Ability to lay up and properly bond intersections on any 8-inch wall and to accurately line up wall having recesses or projections.	Ability to lay up from a rough sketch given by the foreman or the boss.	.....	.....	Trade terms: Intersections, pilasters.	.....	Repetitive training in spreading mortar, placing brick (cutting to length), arranging courses so as to come out even and level with top, laying up left or right hand leads, laying up wall between leads to a line, cutting brick to any length, making bed and vertical joints of even thickness, placing header courses at proper heights, pointing up a struck or weathered joint (laying a rowlock sill with buttered joints, building around sides, laying up inside corners). *Instruction required: How to lay up and properly bond intersections on any 8-inch wall and how to accurately line up wall for recesses or projections.*
14. *Job specification.* Building up inside walls using material that determines wall thickness, not over 8 inches in width.	Ability to cut and lay up walls 6 inches and under in thickness with materials that determine total thickness, such as hollow tile, pyrobar, composition	Should be able to secure from a rough sketch the position of tile shapes and (standard shapes) with their relative position in the	.....	Measurement of tile by a brick unit.	Recognition of stock: Recognize the sizes and shapes of composition blocks used in inside wall construction. Trade terms: Lime blocks, gypsum blocks, hollow tile,	.....	Repetitive training in spreading mortar, laying running bond, arranging courses so as to come out even and level, laying up a left or right hand lead (against a vertical wall), laying wall

Type jobs *a.* Laying up a 3-inch to 6-inch partition wall with lime, gypsum, cement, or hollow-tile blocks without openings. *b.* Laying up a partition wall with lime, gypsum, cement, or hollow-tile blocks with openings not over 4 feet in length.	blocks.	wall. Ability to read three-view sketch of shapes of hollow wall blocks.			beam, split block, channeliron,anchor, partition tile, web, lime, tile, slab, furring.		between leads to a line, laying up and plumbing inside or outside corners, building around sides of openings, spacing courses for a given height, placing and leveling a lintel iron over small openings (not over 4 feet), building around wood or iron fittings. *Instruction required: How to spread mortar on hollow tile, gypsum, and composition blocks, and how to cut hollow-tile and composition blocks.*
15. *Job specification.*—Building up an outside wall with or without openings using weathered or struck joints with materials that determine wall thickness, not over 12 inches. *Type jobs* *a.* Laying up wall for small garage using common brick on edge (rowlock bond). *b.* Laying up wall for small garage using 8-inch by 12-inch hollow tile. *c.* Laying up 12-inch outside curtain wall using hollow tile in fireproof construction.	Ability to lay up outside wall using material such as brick on edge, hollow-tile or composition blocks which determine wall thickness.	.....	Web tile set vertically have greater compression strength. Webs increase the strength of tile. Reinforcement rods increase tensile strength. Reinforcement rods go at bottom of lintel at point of greatest tensile pull. Confined air spaces in the walls act as nonconductors of heat or cold.	Dimensions of standard tile sizes.	Stock recognition: Recognize sizes and shapes of hollow tile used in construction. Trade terms: Reinforcing, rowlock bond, weathered joint, struck joint, trowel joint, sill tile, special corner tile, half-jamb tile, half-closure tile, bearing slabs, nest of slabs.	.....	Repetitive training in picking up and spreading mortar, laying up a left or right hand lead, laying wall between leads to a line, laying up and plumbing inside or outside corners, building around sides of openings, spacing courses for a given height, placing and leveling a lintel iron over small openings not over 4 feet, building around wood or iron fittings, spreading mortar on hollow-tile or composition blocks, cutting hollow-tile and composition blocks. *Instruction required: How to lay up outside walls using brick on edge, hollow-tile or composition block in walls between 8 inches and 13 inches in thickness.*

BLOCK–BL–I.—*Block Base: Jobs Calling for Semifinished Work*—Continued

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
16. *Job specification.*—Laying up an inside 13- or 17-inch brick wall, or thicker where necessary using common bond, semifinish. *Type jobs* *a.* Laying up a 17-inch partition-bearing wall with or without openings. *b.* Backing up cut stone facing of exterior load-bearing wall.	Ability to lay up 13-inch or thicker inside walls, using common bond, tiers properly bonded through wall. Setting anchors and building chases where necessary.	Obtaining from blueprints the layout of courses that will build up even with beds of stone courses.	In bearing walls stone facing and brick backing must be built to act as a unit.	Determining course heights that will meet conditions—stone courses and ceiling heights. Heights of courses are measured from top bed to top bed of facing.	Recognition of stock: Recognize difference in widths of mortar joints used with stone and those customarily used in laying up brick.		Repetitive training in picking up and spreading mortar, laying up a left or right hand lead, laying walls between leads to a line, making a shove joint and not crowding either wall, properly spacing, laying up and plumbing inside tier or 13-inch or thicker wall, filling in between tiers, laying header course on inside tiers at proper height, making bed joints of even thickness, gaging heights with story pole, building over sides of opening, building around sides of opening, placing anchor blocks where indicated, spacing courses in a given height, placing and leveling lintel iron and laying over small opening using a gaged lime or lime-cement mortar, laying up and properly bonding intersections and accurately measuring projections, all up to standards of semifinished work. *Instruction required: How to bond the tiers in a 13-inch, 17-inch*

							or thicker wall using common bond.
17. *Job specification.* Turning simple arches with common brick on 8-inch walls using temporary centers. *Type jobs* *a.* Turning a rowlock segmental arch over a window opening. *b.* Turning a single rowlock arch over a door opening. *c.* Turning a double rowlock semicircular arch over a door or window opening. *d.* Turning a bonded segmental arch over a door opening. *e.* Turning a semicircular arch over a door opening. *f.* Turning a relieving arch.	To lay out and plumb segmental and semicircular arches over temporary supports, and lay out and cut skewback.	Determining skewback by construction devices. Cord or straight-edge for swinging the arc. A simple arch can be constructed by using the span of the opening and constructing isosceles triangle.	An arch distributes load over to the side walls and is self-supporting. The flatter the arch the greater the side thrust. The radius of an arch may be the length of the cord or span of the opening.	Two straight lines intersecting, the opposite angles are equal. The cord of an arc is one side of an isosceles triangle. When two ares are drawn between the same radii the inner arc is the shorter.	Trade terms: Skewback, rowlock, segmental cord, isosceles, radius, radii, semicircular, arch, anchor, haunch, abutment, span, spring, buttering, rise, spandrel, springer, trimmer arch, brick chisel, arched center, template, rib, voussoir, radial joint, gaged arch, thrust, strike centering, creepers.		Repetitive training in spreading mortar, estimating amount of mortar, laying up buttered joints, and pointing up. *Instruction required: How to determine skewback, how to cut bricks for skewback, how to lay up single or double rowlock arch, how to lay up segmental arch, how to lay up a bonded segmental arch, how to lay a single or double semicircular arch, and how to lay up a relieving arch, all over temporary centers.*
18. *Job specification.* Turning arches with common brick on 8-inch walls which require cutting and shaping of brick. Temporary supports in place. *Type jobs* *a.* Turning a segmental arch with brick cut to set over window opening. *b.* Turning a gaged jack or flat arch over a window opening.	Ability to cut brick to proper shape, to lay out and build flat or circular arches over temporary supports.	Determining shape of brick and joints by construction devices—cord or straight-edge.		Determining size of brick on soffits by ratio methods	Trade terms: Centering, camber, gage, cutting, rubbing, spandrel, jack arch, tapered brick.		Repetitive training in spreading mortar, estimating amount of mortar, laying buttered joints, pointing up, determining skewback, cutting bricks for skewback, laying up single or double rowlock arch, laying up segmental arch, laying up bonded segmental arch, laying up single or double semicircular arch, and laying up a relieving arch, all over temporary centers. *Instruction required: How to set centering and how to turn segmental and gaged jack arches.*

BLOCK–BL–I.—*Block Base: Jobs Calling for Semifinished Work*—Continued

Block objective: Ability to do common brick jobs where finished appearance of the work is not an important factor—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
19. *Job specification.*—Backing up stone facing of enclosure walls with brick. *Type jobs* *a.* Backing up facing supported on shelf angles and anchored to backing. *b.* Backing up facing having bond stones that are both bonded and anchored to brick. *c.* Backing up stone facings where windows and metal or other types of spandrels are projected flush with face of wall.	Ability to lay up backing 8 inches or more in thickness with or without bond to stone facing, cutting and bonding brick against a surface certain parts of which project from vertical plane. where necessary, properly tying wall to or around column, placing wall plugs, anchors and other inserts as shown on drawings.	Getting information from drawings as to the proper relationship of finished inside face of brickwork and other materials.	The need for anchoring facing to backing. Importance of tying to structural columns and beams.	Measuring with rule or tape to locate positions of items to be built in.	Trade terms: Wall plugs, anchor belts, inserts, shelf angles, spandrels, pier, recessed panel.	----------	Repetitive training in: Spreading mortar, estimating amount of mortar, making shove joints, laying up leads, filling in between wall and corners, placing anchors and inserts, parging back of facing. *Instruction required: How to fill in spaces in columns, and how to bond brick work around columns, how to wedge brickwork under spandrel beams.*

20. *Job specification.*—cutting out, repairing, and pointing up any semifinished work. *Type jobs* *a.* Toothing out old wall to receive new work. *b.* Cutting out joist sockets on old wall. *c.* Cutting channels and chases in new or old semifinished work. *d.* Cutting out openings and building around frame in old or new semifinished work. *e.* Cutting out and repairing segmental arch over doorway. *f.* Cleaning and rejointing old semifinished work. *g.* Joining pilasters or an intersecting wall to an old wall.	Ability to cut out, repair, and point up any job in semifinished brick work.	Laying off opening full size on old walls from dimension sketch.	Muriatic or commercial hydrochloric acid solution changes an insoluble substance to a soluble one.	----------	Trade terms: Channels, chisel, toothing, joining on, muriatic acid, lapping, toothed chase, dovetail.	Safety: Acid burns hands and clothing.	Repetitive training in anything which the apprentice has learned to do in the preceding jobs according to the requirements of the special job. This will vary with the different jobs, hence no specific statement can be made. *Instruction required: How to lay out for cutting, and how to cut out old or new work, and how to clean and repoint old semifinished work.*

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BRICKLAYING

BLOCK–BL–II.—BLOCK BASE: JOBS CALLING FOR FINISHED WORK

Block objective: Ability to do any brickwork job up to finished standards of the trade

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
1. *Job specification.*—Laying up outside 8-inch face wall with or without openings, using common bond, common brick, with finished appearance. *Type jobs* *a.* Laying up the outside tier of an 8-inch solid brick wall of a small cottage. *b.* Laying up an outside tier of an 8-inch solid wall for a single or double garage. *c.* Laying up the outside tier of a 13″ wall using common bond and backing with 8-inch hollow tile.	Ability to finish face of an 8-inch wall up to trade standards using common bond, struck or weathered joints.		Placing headers either in the sixth or eighth course in an 8-inch wall makes the wall strong enough for all ordinary purposes.	Vertical linear measurement with story pole using brick and mortar joint unit for openings and story heights.	Recognition of stock: Know how to determine the best end and top of brick. Ability to determine the best side and end of brick. Ability to determine rough hard or hard burned, common brick.	What constitutes a safe scaffold and the regular requirements, if any, that are intended to protect the bricklayer. The danger of putting too much material on a scaffold at one time. Trade terms: Rough hard, rough burned, troweled, joint.	Instruction required: How to finish an 8-inch wall, common bond, up to trade standards.
1–*a. Job specification.*—Laying up an 8- or 13-inch wall in common or American bond with or without openings and backed up with brick, tile or cinder block. *Type jobs* *a.* Laying up on the outside tier of an 8-inch	Ability to lay up 8- or 13-inch walls with or without openings in American bond, backing up with various material, finishing with various types of joints.	Securing from manuals and other illustrated material on structural hollow tile, sizes and shapes and methods of using tile at exterior and interior corners.	Local building code regulations determine the type of wall construction that will carry safely various loads.	The structural hollow-tile blocks determine number of courses between headers. This can also be determined by brick mason's rule, which is marked off for different brick gages.	Trade terms: Setting up, tailing out.	Care of tools: Safety: Avoid chips on scaffold and between wall and scaffold.	Repetitive training: Laying up outside tier of a finished wall. *Instruction required: How to back up a 13-inch wall with hollow tile and other approved material.*

wall common bond and backing with brick. *b.* Laying up an outside tier of an 8-inch wall, common bond, and backing with cinder blocks. *c.* Laying up the outside tier of a 13-inch wall using common bond and backing with 8-inch hollow tile.							
2. *Job specification.*—Laying up an 8-inch outside wall, finished appearance, with or without openings, using Flemish bond, common brick, flush or troweled joints. *Type jobs* *a.* Outside wall for a brick cottage. *b.* Outside wall for a small garage.	Ability to lay single Flemish bond on outside wall with common brick, flush or troweled joints.	.....	Header courses will carry moisture from front to back of an 8-inch wall. Moisture will travel from one end of a porous brick to the other end. The greater the number of headers, the more solid the wall.	Ability to accurately estimate one-fourth brick by eye.	Recognition of stock: Ability to pick out the best end of a brick. Trade terms: Flemish bond, double Flemish bond.	Keeping materials from falling off a scaffold, looking out for the security of ladders. Precautions in riding on construction elevators.	Repetitive training: In finishing an 8-inch wall up to trade standards. *Instruction Required: How to lay up a single Flemish bond and how to finish with flush joint.*
3. *Job specification.*—Laying up an outside wall with or without openings, single or double Flemish bond, using face brick and tile backing, struck joints. *Type jobs* *a.* Outside walls of a two-story brick building with or without openings. *b.* Outside wall of a small garage using backer tile.	Ability to lay up an outside face wall with single or double Flemish bond, face brick, struck or raked out joints and backed up with backing tile.	.....	Sufficient headers should be included to equal full headers in every sixth or eighth course.	Course height determined by backer tile length; 4×12×12-inch tile=7 brick; 8×12×12-inch tile=14 brick: 12×12×12-inch tile =21 brick; 4×5×12 - inch tile = 3 brick; 8×5×12-inch=6 brick.	Recognition of stock: Properties: water is not apt to follow through a mortar joint. A 10-inch wall with hollow-tile backing and a Flemish bond brick facing is water-proof and is suitable for house construction. Trade terms: Face brick, wire cut.	.....	Repetitive training: In finishing an 8-inch wall with struck or weathered joints and laying up single Flemish bond up to trade standards. *Instruction required: How to lay up a double Flemish bond using face brick. How to make a raked out mortar joint, and how to back up wall with backing tile.*

BLOCK–BL–II.—*Block Base: Jobs Calling for Finished Work*—Continued

Block objective: Ability to do any brickwork job up to finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
4. *Job specification.*—Laying up an 8-inch or 13-inch wall English or Dutch bond, rodded joints. *Type jobs* *a.* Laying up a wall with surface design frieze using English or Dutch bond. *b.* Laying up a single bordered panel on face of 8-inch or 12-inch wall, using English or Dutch bond, rodded joint.	Ability to lay up English or Dutch bond, with raked or rodded joint.	.....	.....	.....	Recognition of stock: Ability to recognize brick having both ends perfect. Trade terms: English bond, Dutch bond, frieze, rodded joint, closures.	.....	Repetitive training in finishing an 8-inch or 13-inch wall, backing up with backing tile and making raked out mortar joints in a workmanlike manner up to trade standards. *Instruction required: How to lay up an English or Dutch bond in 8-inch or 13-inch wall and how to make a rodded joint.*
5. *Job specification.*—Outside or inside finished wall with rectangular or vertical header border. *Type jobs* *a.* Rectangular header surface around window opening. *b.* Header belt course in an 8-inch or 13-inch wall. *c.* A driveway framed with stretcher courses. *d.* Porch floor with bordered panel.	Ability to lay out bordered panels from sketch or detail on inside and outside finished brick work, in common or English bond, any joint.	.....	.....	Given the length of the base and the side, to construct a rectangle.	.....	.....	Repetitive training in finishing an 8-inch or 13-inch wall with struck weathered, raked or rodded joints, laying up running and English bond, backing up with backing tile. *Instruction required: How to lay out from a sketch and how to lay up bordered panels on inside or outside work.*

6. *Job specification.*—4-inch brick veneer tied to a frame structure. *Type jobs* *a.* Veneering the outside of a 2-story frame house. *b.* Veneering the outside of a frame building over the original outside surface.	Ability to properly lay and tie veneer work on the new or old frame buildings.				Trade terms: Flashing, tie irons, galvanized ties, wire tie irons.		Repetitive training in laying up running, English or Flemish bond, with struck, weathered, raked or rodded joints, all in a workmanlike manner up to trade standards. *Instruction required: How to tie brick veneer to new or old frame buildings.*
7. *Job specification.*—Outside or inside finished work with projected or receding surfaces, faced brick, finished appearance. *Type jobs* *a.* 13-inch wall with recessed panel in running, Flemish or English bond. *b.* Outside wall with pilaster facing. *c.* Sill course with rusticated facing.	Ability to lay out from a sketch and lay up in common, Flemish or English or Dutch bond finished work having projected or recessed surfaces.		Increasing thickness of the wall with pilasters makes the wall strong enough to carry the floor load.	To divide a given distance into a given number of parts. Total space divided by number of pilasters gives distances between center lines of pilasters.	Trade terms: Pressed brick, rough texture, "tapestry" brick, beams, rusticated.		Repetitive training in finishing an 8-inch or 13-inch wall using struck, weathered, raked, or rodded joints, laying up running, single Flemish, double Flemish, English or Dutch bond, backing up with backing tile, laying out from sketch bordered panels, all in a workmanlike manner up to trade standards. *Instruction required: How to lay out from a sketch and how to lay up walls with projected or recessed surfaces.*
8. *Job specification.*—Outside or inside work with both surfaces finished. *Type jobs* *a.* 8-inch garden wall with Dutch or English bond. *b.* Partition wall finished on both sides.	Ability to lay up a double-thickness wall finished on both sides in Dutch or English bond, any joint.						Repetitive training in finishing an 8-inch wall with struck, weathered, raked or rodded joints, laying up Dutch or English bond, laying out from sketch bordered panels with projected or recessed surfaces. *Instruction required: How to lay up a wall finished on both sides.*

BLOCK–BL–II.—*Block Base: Jobs Calling for Finished Work*—Continued

Block objective: Ability to do any brickwork job up to finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
9. *Job specification.*—Outside or inside finished work with recessed or projected portions calling for curved lines. *Type jobs* *a.* Filling in around a window or door frame with a bordered circular arch head. *b.* Filling in over a door frame having an irregular head with border recessed or projected.	Ability to lay out and cut recessed or projected work having surfaces with curved lines and to lay up the wall to standard practice requirements.	----------	----------	Divide the distance between two concentric arcs over an ellipse into segments of the same size. To determine the foci of a given ellipse from known radii, using a string or other device.	Trade terms: Elliptical, elliptical arch.	----------	Repetitive training in finishing an 8-inch or 13-inch wall with struck, weathered, raked, or rodded joints laying up common, Flemish, English, or Dutch bond backing up with backing tile, laying out and laying up bordered panels, laying out projected or recessed surfaces, laying up wall finished on both sides. *Instruction required: How to lay out from sketch and how to cut recessed or projected work having surface with curved lines.*
10. *Job specification.*—Plain, recessed, or projected surfaces having openings with arcs or two separate circles intersecting. *Type job* *a.* Laying up a Gothic arch over a temporary form. Using face	Ability to lay out and lay up gothic arches and build a field of brick about arch in any bond.	----------	A gothic arch has less sideways thrust than any other form of arch. Cement mortar is stronger than lime mortar, and sets quicker.	Find the centers of two intersecting arcs of equal radii, both centers in same horizontal line.	----------	----------	Repetitive training in finishing an 8-inch or 13-inch wall using struck, weathered, raked, or rodded joints, laying up common, single Flemish, double Flemish, English, or Dutch bond, backing up with backing tile, laying out cutting

brick, any joint with or without projections.						and laying up from sketch bordered panels, laying out and cutting for projected or recessed surfaces on both straight and curved lines. *Instruction required: How to lay out and lay up a Gothic arch.*
11. *Job Specification.*—Laying up outside or inside wall with projected or recessed panels having vertical or horizontal pattern arrangement. *Type jobs* *a.* Laying up herringbone or basket-weave pattern on panel between pilasters. *b.* Laying up basket or herringbone pattern design on a border frieze on a 9-inch or 13-inch wall. *c.* Laying up an interior wall with herringbone design, any joint.	Ability to lay out from sketch, cut brick to design, and lay up any job calling for vertical or horizontal pattern designs on a recessed or projected surface.					Repetitive training in finishing an 8-inch wall using struck, weathered, raked, or rodded joints, laying up common, single Flemish, double Flemish, English, or Dutch bond, backing up with backing tile, laying out, cutting, and laying up from sketch bordered panels, laying out projected or recessed surfaces on both straight or curved lines, and laying out and laying up a gothic arch. *Instruction required: How to lay out from sketch pattern designs on horizontal or vertical recessed or projected surfaces.*

BLOCK–BL–II.—*Block Base: Jobs Calling for Finished Work*—Continued

Block objective: Ability to do any brickwork job up to finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
12. *Job specification.*—Surface pattern from layout having regular or irregular curves. *Type jobs* *a.* Laying up a band course with repeating circular pattern de-designs. *b.* Laying up an inside surface panelling with circular pattern designs.	Ability to lay out any surface pattern with regular or irregular curves and lay up to meet standard trade practice.	----------	----------	To divide a circle into a given number of segments.	----------	----------	Repetitive training in finishing an 8-inch or thicker walls using struck, weathered, raked, or rodded joints, laying up running, single Flemish, double Flemish, English or Dutch bond, backing up with backing tile, laying out, cutting, and laying up from sketch bordered panels, tying veneer to old or new work, laying out projected or recessed surfaces in both straight or curved lines (laying out and laying up a gothic arch), and laying out from sketches pattern designs on horizontal or vertical recessed or projected surfaces all in a workmanlike manner up to trade standards. *Instruction required: How to lay out from sketch surface patterns with regular or irregular curved line.*

13. *Job specification.*—Laying up straight surface with glazed brick, common bond. *Type jobs* *a.* Straight work on outside walls, using glazed brick, common bond. *b.* Inside veneered straight walls with base and cap courses. *c.* Laying up partition walls of glazed brick finished on both sides.	Ability to lay up in any bond, straight inside or outside work using glazed brick up to finish of standard practice.	Reading setting drawings to determine position of base course and location of special shapes.	If glazed surface is broken water will penetrate and eventually destroy surface on outside work. Glazed surfaces must be cut with abrasive wheels.		Recognition of stock: Ability to recognize glazed or enameled brick in usable condition. Working properties: glaze is very hard and chips off easily. Trade terms: Buttered joints, flat stretcher, binder, enameled, enameled finish, glaze, washing, cleaning, bull nose, cove, slope.		Repetitive training: In finishing face of an 8-inch or thicker wall, laying up running, bond, backing up with backing tile or brick, laying out from sketch and tying veneer work to old or new work. *Instruction required: How to lay out and lay up glazed brick and tile on straight inside or outside work.*
14. *Job specification.*—Laying up glazed brick in any special form in any position. *Type jobs* *a.* Straight outside work with window or door openings using glazed brick over any special form. *b.* Veneered inside wall with base and cap course such as found in offices, restaurants, and corridors. *c.* Partition wall finished on both sides as found in restaurants, hospitals, and offices. *d.* Side walls having window and door openings finished with special forms of glazed brick. *e.* Shower-enclosure walls. Side walls finished on both sides.	Ability to lay up any special form of glazed brick work using any standard or special shapes on inside or outside jobs up to standard finish.	Securing from setting drawings, dimensions, shapes and method of laying up various courses.			Recognition of stock: Ability to recognize all forms of enameled and glazed brick such as lintel, headers, starters, standard bull nose, flat stretcher, flat header, flat stretcher bull nose, flat-header, cove header, cove stretcher, cove quoin, cove bull nose, cove miter, ogee, headers, stretchers, miters. Trade terms: Bull nose, cove, chamfer, external octagonal, internal octagonal, cove miter, ogee header, miter, lintel header, stretcher header, cap, standard starter.		Repetitive training: In finishing face of an 8-inch or thicker wall, laying up running bond, backing up with backing tile, laying out from sketch and tying veneer work to old or new work, laying out bordered panels having projected or recessed surfaces, laying up wall finished on both sides, laying out and cutting recessed or projected surfaces with curved lines, laying up surfaces with vertical or horizontal pattern designs on recessed or projected surfaces, laying up with buttered joints. *Instruction required: How to lay out and lay up any special shapes of glazed brick on inside or outside jobs.*

BLOCK–BL–II.—*Block Base: Jobs Calling for Finished Work*—Continued

Block objective: Ability to do any brickwork job up to finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
15. *Job specification.*—Laying up molded brick of any shape placed in horizontal or vertical positions, projected or recessed, on inside or outside work with any joint. *Type jobs* *a.* Entrance gateway with molded brick base and caps. *b.* Projecting cornice on residence or apartment building. *c.* Projecting water table on any building. *d.* Inside veneered panel with recessed base and cap as in cornice in residence or office buildings.	Ability to lay out and lay up molded brick shapes on jobs involving horizontal and vertical projected or recessed work, with any joint, up to trade practice.	Ability to read sketch or setting drawing giving courses, shapes, arrangements, dimensions, width, and types of joints.	.....	.....	Recognition of stock: Identification of pieces by course and brick numbers. Trade terms: Bead, half round, quarter round, dentil, crown, bed, bed mold, crown mold, hoists, tackle.	.....	Repetitive training: In finishing up an 8-inch or thicker wall common, Flemish, English or Dutch bond, with any joint, laying out and laying up bordered panels with projected or recessed surfaces on 8-inch or 13-inch walls, tying veneer work to old or new walls, backing up with backing tile, laying up walls finished on both sides, laying up walls having surfaces with curved lines (laying up Gothic arches), laying out surface patterns with regular or irregular curves on recessed or projected surfaces. *Instruction required: How to lay out and lay up molded brick shapes on surfaces having horizontal or vertical projected or recessed designs.*

16. *Job specification.*—Laying up all kinds of molded or ornamented brick in which plan is irregular or curved and any surface pattern using molded or ornamented brick. *Type jobs* *a.* Circular rectangular pedestal. *b.* Base shaft and cap of circular column. *c.* Base with base and band courses or cornice of molded or ornamented brick. *d.* Single or group of chimneys, circular or octagonal in plan with surface patterns.	Ability to lay up all kinds of molded or ornamented brick in circular or irregular plan with any surface pattern with highest grade of finish using any kind of bond.	Interpreting any setting drawing involving art in plan and elevation.			Trade terms: Bay, spiral, chimney, shaft, column.	Repetitive training: In finishing up an 8-inch or thicker wall, common, Flemish, English, or Dutch bond, with any joint, laying out and laying up bordered panels with projected or recessed surfaces on 8-inch or 13-inch walls, tying veneer work to old or new walls, backing up with backing tile, laying up walls finished on both sides, laying up walls having surfaces with curved lines, laying up Gothic arches, laying out surface patterns with regular or irregular curves on recessed or projected surfaces, laying out and laying up molded brick shapes on surfaces having horizontal or vertical, projected or recessed designs. *Instruction required: How to lay up molded or ornamental brick, circular or irregular in plan in any surface pattern; how to read setting drawing showing layout of molded or ornamental brick.*

BRICKLAYING

BLOCK–BL–III.—BLOCK BASE: JOBS CALLING FOR THE SETTING OF ARCHITECTURAL TERRA COTTA AND CUT-STONE TRIM

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
1. *Job specification.*—Setting a one-piece cut-stone slip sill. *Type jobs* *a.* Setting a one-piece cut-stone slip window sill in a panel or curtain wall. *b.* Setting a one-piece cut-stone lug sill in a brick wall. *c.* Setting a one-piece cut-stone door sill.	Ability to set a one-piece cut-stone slip sill.	Window and door openings are usually located on drawings by dimension lines giving the distance of opening from corner to center of sill.	Water has very little effect on stone if allowed to drain off. Ends of lug sills take the load from above. The center does not carry the load.	Linear measurement to one-eigth inch. Device: A rule.	Stock recognition: Ability to recognize sandstone, limestone, granite, marble, and brownstone Sandstone, limestone and marble are soft and easily broken. Trade terms: Sandstone, limestone, granite, marble, slip sill, lug sill, bevelled sill, drip, court walls, setting mortar.	----------	Instruction required: How to prepare mortar bed for stone and how to place in position on brick wall any one-piece cut-stone sill.
2. *Job specification.*—Setting one-piece terra cotta on brickwork. *Type jobs* *a.* A one-piece terra cotta sill under a window. *b.* A chimney capping. *c.* Setting a one-piece lintel over a small window opening. *d.* Setting a one-piece terra cotta insert in a brick wall.	Ability to prepare a mortar bed of proper thickness, place and force into position any single piece of terra cotta such as copings, single piece sills, lintels, where no anchoring is required.	----------	----------	----------	Stock recognition: A recognition of warped or imperfect pieces, imperfections in glazing. Recognize the difference between a glazed and and a mat surface. Working properties: Spaces between webs must be filled in with mortar. Distinguish between cement mortar and lime mortar. Trade terms: Web surface, mat surface, glazed surface, chimney top, chimney flue, cappings, cop-	----------	Instruction required: How to prepare properly a mortar bed for terra cotta, place and force into position any single piece of architectural terra cotta such as copings single piece sills, lintels, where no anchoring is required.

					ings, washes, lip, drips, overhang, flush lugs.		
2 A. *Job specification.*—Setting one-piece cut-stone trim in brick building. *Type jobs* *a.* Setting a one-piece cut-stone lintel.	Ability to properly bed lintel stone on brick jambs over openings.	.....	Lintel used as structural member to transmit load to piers. Hoists are mechanical devices for lifting heavy loads. Width of opening determines number of rowlocks in relieving arches.	.....	.....	Safety: Avoid dropping stone. If necessary, brace until backing is in place.	Instruction required: How to bed, set, and line up lintel with other lintels properly braced.
3. *Job specification.*—Setting terra cotta pieces same size and pattern on brick wall not over 13 inches thick. *Type jobs* *a.* Setting a terra cotta wall coping on walls not exceeding 13 inches. (Cornices if required.) *b.* Setting a two-piece window sill with raised joints, on brick building.	Ability to set to line and join two or more similar pieces of terra cotta.	.....	.....	Joint width equals total space to be filled minus total length of pieces, divided by one less than the number of pieces. Estimation made by eye.	Recognition of stock: Recognize construction marks or indications. Trade terms: rebate, lug, void, dowel, setting to line, joints, ceramic, smooth, circular, arris, "shadow line," salt glazed, 9 × 13-inch corner coping, 9 × 9-inch corner coping.	Safety: Poorly bedded terra cotta pieces may work loose and fall from building. Hence the need of being very careful to do a good bedding job. Terra cotta pieces are heavier than brick, hence more damages likely to result if they fall down. Care should be exercised in handling.	Repetitive training in: preparing properly a mortar bed for terra cotta, placing and forcing into position single pieces of terra cotta such as sills, where no anchoring is required. *Instruction required: Ability to set to line and join two or more similar pieces of terra cotta.*
4. *Job specification.*—Setting several pieces of stone trim with end joints as in a base course. *Type jobs* *a*–1. Setting a stone base or grade course. *a*–2. Setting a minor water table course. *b.* Setting a cut-stone coping.	Ability to set several pieces of stone trim with end joints.	Drawings indicate height of grade stone. Setting drawing indicates length of individual stones and position in wall.	Wetting of stone prevents rapid absorption of water from setting mortar. Waterproof material stops moisture through capillary action.	Distributing a number of distances in a given length so as to have the same space for all mortar joints.	Recognition of stock: Working face and outside corners. Trade terms: Water-table, coping, dowels, grade course.	.....	Repetitive training in preparing properly a mortar bed for a stone trim and placing in position on brick wall. *Instruction required: How to set several pieces of stone trim with end joints and how to place dowels.*

BLOCK–BL–III.—*Block Base: Jobs Calling for the Setting of Architectural Terra Cotta and Cut-stone Trim*—Continued

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
5. *Job specification.*—Setting one-piece terra cotta bedded and anchored on brick work. *Type jobs* *a.* Setting a keystone in a flat brick arch over steel lintels. *b.* Setting quoins on corner of brick building. *c.* Setting a terra cotta keystone on segmental arch opening not over 3 feet in width. *d.* Setting terra cotta skewbacks in a brick building and filling in between skewblock and keystone with brick.	Ability to properly anchor small pieces of terra cotta upon brickwork and back up with mortar in construction where there is no great amount of projection.	----------	----------	Gage system of designating wire sizes by numbers. Method of designating sizes and thickness of strap iron (inches and fractions of an inch). System of designating bolt sizes and length by inches and fractions of an inch.	Trade terms: Anchor strap, clip, galvanized iron, bolt, diameters, head, shank, nut, thread, washer.	----------	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position of single pieces of terra cotta, such as sills. *Instruction required: Ability to anchor properly small pieces of terra cotta upon brickwork and back up with mortar in construction where there is no great amount of projection.*
5–*a. Job specification.*—Setting one-piece cut-stone trim exposed on three or more sides. *Type jobs* *a.* Setting a one-piece plinth or base stone and a cap stone in a brick pier.	Ability to locate position of single piece of stone similar to the base of a gate post from survey stakes or plat plan, setting level and plumb on prepared foundation.	Locating position of single stone from plat.	Block and tackle applies leverage principles—work done on lifting end equal to energy expended on pulling end.	----------	Trade terms: Plinth, block, cap stone, finial, flashing, block and tackle, derrick.	----------	Repetitive training in preparing properly mortar bed, leveling, plumbing. *Instruction required: How to lift and lower single heavy piece of stone, setting plumb and level on mortar bed, placing flashing where needed, using screed to prepare bed to proper thickness.*

6. *Job specification.*—Setting, anchoring, and joining several pieces of terra cotta of the same size and pattern with slight overhanging projections. *Type jobs* *a.* Setting a two-piece wall coping with not over 5-inch projections (overhung) on a 13-inch to 17-inch wall. *b.* Setting a terra cotta sill of several pieces for openings, not over 4 feet in length. *c.* Setting a segmental terra cotta arch for openings not over 4 feet in width. *d.* Setting a plain base or band course on inside or outside brick or tile wall.	Ability to lay up a series of slightly projecting terra cotta pieces working either on inside or outside scaffold.	Reading a simple sketch made by a foreman, showing conventional method of indicating terra cotta in plan and sketch.	A piece of terra cotta of any size is less likely to wobble if suspension bolts are fastened near the top and setting bolts are fastened near the bottom.	Pins and rods are measured by diameter and length. This measurement is in inches and fractions of an inch.	Trade terms: Hung, anchor, pin par, channel iron, support, wrought iron.	----------	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position single pieces of terra cotta, such as copings, single-piece sills, and lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly anchoring small pieces of terra cotta upon brickwork and backing up with mortar. *Instruction required: Ability to lay up a series of slightly projecting terra cotta pieces working either on inside or outside scaffold.*
6–*a. Job specification.*—Setting, anchoring, and joining several pieces of cut-stone trim having plain or molded faces and cut with or without slight overhanging projections. *Type jobs* *b.* Setting plain band on molded belt course. *c.* Setting one-piece cornice on molded water table course. *d.* Setting cut-stone cornice consisting of two or more members.	Ability to set, anchor and join several pieces of cut stone and line up parallel with face of wall.	Reading setting drawings and locating pieces by number in proper place in wall.	----------	----------	Trade terms: Belt course, band course, intake course, cornice, water table, Lewis, dogs, key ways, cramps.	----------	Repetitive training in preparing properly a mortar bed, setting stone with end joints, placing anchors and dowels. *Instruction required: How to grout and calk vertical joints in stone, wedging or propping of overhanging stone, protecting wash surfaces during process of construction, pointing after calking is removed, placing cramps and keys.*

BLOCK–BL–III.—*Block Base: Jobs Calling for the Setting of Architectural Terra Cotta and Cut-stone Trim*—Continued

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
7. *Job specification.*—Setting cut-stone quoins and window jambs and head in a brick-constructed house. *Type jobs* *a.* Setting cut-stone quoins in corner of brick building. *c.* Setting a simple cut-stone jamb and lintel about a rectangular window opening in a brick house. *d.* Setting cut-stone quoins and lintel of a door opening in a brick building.	Ability to set quoins, jambs, and lintel in a brick building.	Be able to read a working drawing and take off location of quoins, jambs, and lintel in section sketch and plan.	Lintel stones should be of sufficient depth to carry load. Three-piece lintels are constructed as an arch.	.....	Trade terms: Quoin, tooled face, hammered face, rusticated face, skewback.	.....	Repetitive training in preparing properly a mortar bed for stone trim. Setting one-piece cut-stone trim. *Instruction required: Ability to set quoins, jambs, and lintel in a brick field.*
8. *Job specification.*—Turning an opening with a flat arch using terra cotta anchored to any wall. *Type jobs* *a.* Setting a three-piece flat arch over a doorway. *b.* Setting terra cotta trim above a window having a flat lintel.	Ability to set and anchor a flat arch to any wall.	.....	Red lead keeps iron from rusting.	.....	Trade terms: Red lead, band, architrave, soffit, reinforcing, casement.	.....	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position any single piece of terra cotta such as copings and lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly anchoring small pieces of terra cotta upon

c. Setting the sides and turning the arch over a window frame having a flat lintel. d. Setting a terra cotta plaque made up of several pieces in the face of a brick wall.							brickwork and backing up with mortar in construction where there is no great amount of projection. Laying up a series of slightly projecting terra cotta pieces, working either on inside or outside scaffold. *Instruction required: Ability to set and anchor a flat arch to any wall.*
9. *Job specification.* Setting stone keystones and flat arches in brick field.	Ability to set arches, using cut-stone trim of any number of pieces.				Trade terms: Voussoirs.		Repetitive training in preparing properly a mortar bed for stone trim. Setting several pieces of stone trim with end joints. Setting stone quoins, jambs, and lintels in a brick field. *Instruction required: Ability to set arches using cut-stone trim of any number of pieces.*
Type jobs							
a. Setting keystone in brick arch of any shape. b. Setting stone skewback and keystone in brick arch. c. Setting stone jack arch in brick wall.							

BLOCK–BL–III.—*Block Base: Jobs Calling for the Setting of Architectural Terra Cotta and Cut-stone Trim*—Continued

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
10. *Job specification.*—Setting terra cotta trim calling for intersections, anchoring supports to the surrounding walls. *Type jobs* *a.* A mullioned window frame with molded jambs, outside trim. *b.* A small mullioned window with inside and outside terra cotta trim.	Ability to lay out and set a variety of terra cotta pieces some of which intersect, and to work from a sketch or setting drawing showing location of courses and serial numbers.	.....	.....	Rnning a series of parallel lines at fixed distances apart, to any side of a parallelogram.	Trade terms: Dowels, mullioned, shelf, angle, cap, course, bars, molded jambs.	.....	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position any single piece of terra cotta such as copings, single piece sills, and lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly anchoring small pieces of terra cotta upon brickwork and backing up with mortar in construction where there is no great amount of projection. Laying up a series of slightly projecting terra cotta pieces working either on inside or outside scaffold. Setting jambs and lintels in a brick field. *Instruction required; Ability to lay out and set a variety of terra cotta pieces some of which intersect, and to work from a sketch or setting drawing showing location of courses and serial numbers.*
11. *Job specification.*—Setting cut-stone trim calling for intersection.	Ability to lay out, set, and dowel together a variety of cut-stone pieces	Locating stone trim from setting drawing.	.....	.....	Trade terms: Mullion, transom, bar, casement window, false jointing.	.....	Repetitive training in preparing properly a mortar bed for stone trim and placing

Type jobs *a.* A stone mullioned window opening with molded jambs set in a brickfield.	some of which intersect.						singe piece in position. Setting several pieces of stone trim with end joints. Setting stone jambs and lintels in a brick field. *Instruction required: Ability to lay out and set a variety of cut-stone pieces which intersect, forming joint sill and lintel.*
12. *Job specification.*—Setting terra cotta as a veneered surface anchored to any backing. *Type jobs* *a.* Laying up veneered walls below cornices with terra cotta using plain ashlar or square tile design. *b.* Laying up and anchoring base and wall around window and door openings using ornamental terra cotta backed with hollow tile or brick.	Ability to point up on any sort of a bond on terra cotta.	Taking off courses and runs from setting drawing.	Anchoring the veneered surface makes the backing carry the load.		Trade terms: Ashlar, bond, veneer.	----------	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position any single piece of terra cotta such as copings, single-piece sills, and lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly anchoring small pieces of terra cotta upon brick work and backing up with mortar in construction where there is no great amount of projection. Laying up a series of slightly projecting terra cotta pieces, working either on inside or outside scaffold. Setting and anchoring a flat arch to any wall. Laying out and setting a variety of terra cotta pieces, some of which intersect, and working from a sketch or setting drawing showing location of courses and serial numbers. *Instruction required: Ability to point up any sort of a joint on terra cotta.*

BLOCK–BL–III.—*Block Base: Jobs Calling for the Setting of Architectural Terra Cotta and Cut-stone Trim*—Continued

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
13. *Job specification.*—Setting column or pilaster veneering of terra cotta about a steel or reinforced support. *Type jobs* *a.* Setting and anchoring base and shaft of doric column around an H beam. *b.* An octagonal column with cap and base. *c.* A column with ornamental shafts. *d.* A pilaster with Corinthian base and cap. *e.* Setting a terra cotta pilaster with molded base.	Ability to set veneer around structural columns either circular or octagonal in plan.	----------	Terra cotta is not as strong as the material that is used to back it up.	----------	Trade terms: Flashing.	----------	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position any single piece of terra cotta such as single-piece sills or lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly anchoring small pieces of terra cotta upon brick work and backing up with mortar in construction where there is no great amount of projection. Setting and anchoring a flat arch to any wall. Laying out and setting a variety of terra cotta pieces, some of which intersect, and working from a sketch or setting drawing showing location of courses and serial numbers. Pointing up on any sort of a joint on terra cotta. *Instruction required: Ability to set veneer around structural columns, either circular or octagonal in plan.*

14. *Job specification.*—Setting ornamental terra cotta with uneven surfaced around openings. *Type jobs* *a.* Setting a wall with a door opening having flat arch, paneled jamb and soffit. *b.* Setting a wall with segmental arched door openings with molded piers and jambs. *c.* Setting a terra cotta wall fountain made up of several pieces in an inside or outside wall.	Ability to set terra cotta pieces having irregular projected surfaces.						Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing into position any single piece of terra cotta such as copings, single-piece sills and lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly a choring small pieces of terra cotta upon brickwork and backing up with mortar in construction where there is no great amount of projection. Laying up a series of slightly projecting terra cotta pieces, working either on inside or outside scaffold. Setting quoins, jambs and lintels in a brick field. Setting and anchoring a flat arch to any wall. Laying out and setting a variety of terra cotta pieces some of which intersect, and working from a sketch or setting drawing showing location of courses and serial numbers. Pointing up on any sort of a joint on terra cotta. Setting veneer around structural columns, either circular or octagonal in plan. *Instruction required: Ability to set terra cotta pieces having irregular-projecte surfaces.*

BLOCK–BL–III.—*Block Base: Jobs Calling for the Setting of Architectura Tlerra Cotta and Cut-stone Trim*—Continued

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
15. *Job specification.*—Setting ornamental architectural terra cotta projecting over surfaces and edges requiring the use of anchors and supports. *Type jobs* *a.* Anchoring and setting a two- or three-piece projecting cornice on a terra cotta faced building. *b.* Supporting and setting a projecting balcony on a brick-constructed building.	Ability to anchor and set terra cotta pieces projecting over edges and surfaces.				Trade terms: Balustrade, modillion, bracket, gutter, lookout, frieze.	Safety: Poorly anchored and supported overhanging terra cotta pieces are apt to fall; hence the need of special care in properly anchoring and supporting.	Repetitive training in preparing properly a mortar bed for terra cotta, placing and forcing in position any single piece of terra cotta such as copings, single piece sills, and lintels. Setting to line and joining two or more similar pieces of terra cotta. Properly anchoring small pieces of terra cotta upon brickwork and backing up with mortar in construction where there is no great amount of projection. Laying up a series of slightly projecting terra cotta pieces working either on inside or outside scaffold. Setting and anchoring a flat arch to any wall. Laying out and setting a variety of terra cotta pieces some of which intersect, and working from a sketch or setting drawing showing location of courses and serial numbers. Pointing up on any sort of a joint on terra

							cotta. Setting veneer around structural columns either circular or octagonal in plan. Setting terra cotta pieces having irregular projected surfaces. *Instruction required: Ability to anchor and set terra cotta pieces projecting over edges and surfaces.*
16. *Job specifications.*—Setting and anchoring of turned or molded and carved ornamental cut-stone trim either in one or more pieces, at considerable height above ground. *Type jobs* *a.* Setting cut-stone finials, urns and pinnacles on brick piers. *b.* Setting cut-stone features on large pier, tourelles or turrets.	Ability to work from high scaffold, assist in setting hoisting rig, fastening rope slings and anchoring slender stone.	----------	----------	----------	----------	----------	Repetitive training in making mortar bed for single stone, hoisting stone in position, setting over anchors, grouting of vertical joints. *Instruction required: How to anchor rods to support slender pieces of stone and setting cramps in stone.*

BLOCK–BL–III.—*Block Base: Jobs Calling for the Setting of Architectural Terra Cotta and Cut-stone Trim*—Continued

Block objective: Ability to set architectural terra cotta and cut-stone trim up to the finished standards of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
17. *Job specification.*—Setting and anchoring ornamental architectural cut - stone features, such as entrances, bay windows, porches, porticoes, balustrades and balconies. *Type jobs* *a*–1. A raking pediment. *a*–2. A broken raking pediment. *a*–3. A curved pediment. *a*–4. Broken pediment with provision for oval window above entrance. *b*. Porch or terrace balustrade of simple type. *c*. Balcony in balustrade. *d*. Parapet or attic story balustrade. *e*. Setting stone columns and lintel stone. . Setting and anchoring cut-stone portico feature. *g*. Setting mullioned bay window. *h*. Setting splayed oriel window.	Ability to place large stone in horizontal position, place dowels, set and line up balustrades, set, prop up, and anchor bracket support and ability to place rope slings and hoist plumb and set above column.	.....	The several classes of leverage are used for anchoring projecting stone work to walls of brick masonry. Steel under load always deflects. Steel over stone must be blocked up.	.....	Trade terms: Plastic, mortars, platform, balcony, bay window, oriel window, column, pilaster, lead buttons, capitals, portico, loggia.	.....	Repetitive training: Practically all of the stone setting operations listed in previous jobs. *Instruction required: How to set up, hoist and fasten various lifting devices, placing and building around steel members used as anchors, placing of Lewis anchors in stone.*

BLOCK–BL–IV.—BLOCK BASE: JOBS CALLING FOR THE SETTING OF REFRACTORY MATERIALS

Block objectives: Ability to repair and set firebrick work of any form up to standard requirements of the trade

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
1. *Job Specification.*—Laying up fire brick surfaces on brick walls. *Type jobs* *a.* Bridge wall of small tubular boiler setting. *b.* Lining the side of a fire box on a small boiler. *c.* Lining the sides of an incinerator. *d.* Walls in a reverberating copper-smelting furnace. *e.* Walls of the air checker chambers under a glass tank.	Ability to lay refractory brick with close-fitting joints on prepared vertical or horizontal flat surfaces.	Securing from setting drawings the dimensions, location, shapes, and details of construction.	Fire and brick clay will withstand extreme heat. Mortar will not withstand heat. Fire clay is a poor heat conductor. Heat expands firebrick and mortar. Fire brick will absorb moisture. Firebrick will disintegrate rapidly when exposed to frost.	Use of table of dimensions for different sizes of boilers. Use of tables to determine firebrick sizes and shapes.	Recognition of stock: Distinguish firebrick from common brick by appearance and size. Trade terms: Bridge, wall, firebrick, back wall, lining, fire clay, longitudinal sketch, brick shelf, fire door, fire box, slice bars, refractory material, rubbed joint, soot door, gate, ash pit, piers. arch tile.	.....	Ability to lay with a brick-to-brick joint, firebrick walls on prepared vertical or horizontal flat surfaces.
2. *Job Specification.*—Laying up firebrick lining in circular chamber. *Type jobs* *a.* Lining a base of chimney stack. *b.* Lining a horizontal steel flue or stack. *c.* Lining a rotary cement kiln. *d.* Lining a cupola. *e.* Lining electric steel-melting furnace. *f.* Lining water-gas generator set. *g.* Lining a copper converter. *h.* Lining a blast furnace.	Ability to lay up fire-brick lining using regular sizes and special shapes on the inside of circular walls.	.....	Air is a nonconductor (perforated brick).	Use of tables to determine proper radial bricks for circumference of stack.	Recognition of stock: Ability to recognize circular, square, and wedge-shaped firebrick. Trade terms: Radial, key brick, radial brick, thimble, perforated radial, shell, breaching openings.	.....	Repetitive training in laying with a brick-to-brick joint, firebrick walls on prepared vertical or horizontal flat surfaces. *Instruction required: Ability to lay up fire brick walls, using regular sizes and special shapes on the inside of circular walls.*

BLOCK–BL–IV.—*Block Base: Jobs Calling for the Setting of Refractory Materials*—Continued

Block objectives: Ability to repair and set firebrick work of any form up to standard requirements of the trade—Continued

Job		Trade technical knowledge			Auxiliary information		
Type job	Objective	Drawing	Science	Mathematics	Recognition of stock; trade terms	Care of tools; safety	Training progression
3. *Job specification.*—Laying up a firebrick wall and setting an arch. *Type jobs* *a.* Lining a fireplace. *b.* Laying up an arch over a fire door in boiler firebox. *c.* Laying a firebrick wall under a self-supporting arch. *d.* Laying a firebrick wall for a load-bearing arch. *e.* Cutting and setting skewback for arch. *f.* Setting arch block on temporary wooden arch.	Ability to lay up and fit a self-supporting arch of firebrick or an arch supported on steel members.				Trade terms: Fireplace, back, jamb, inner hearth, outer hearth, damper, ash dump, flue, incinerator.		Repetitive training in laying with a brick-to-brick joint, firebrick walls on prepared vertical or horizontal flat surfaces. Laying up firebrick walls with regular and special shapes on the inside of a circular wall. *Instruction required: Ability to lay and set a self-supporting arch of firebrick under a brick self-supporting arch or on steel members.*
4. *Job specification.*—Laying firebrick wall on inside of brick crown. *Type jobs* *a.* Lining the top of an enameling furnace. *b.* Lining the top of a welding furnace.	Ability to lay up a firebrick lining in the form of a brick crown.						Repetitive training in laying a brick-to-brick joint, firebrick walls on prepared vertical or horizontal flat surfaces. Laying up firebrick walls with regular and special shapes on the inside of a circular wall. Laying and setting a self-supporting arch of firebrick under a brick self-supporting arch.

							Instruction required: Ability to support work on the inside of a brick crown, using firebrick.
5. *Job specification.*—Repairing sections of walls, arches, and floors of industrial furnaces, ovens, kilns, and tanks. *Type jobs* *a.* Laying up the inside of a pottery kiln. *b.* Laying up the inside of a brick kiln. *c.* Lining the top of a blast furnace. *d.* Repairing flux box in a glass tank. *e.* Repairing tops on generators. *f.* Repairing wall under self-supporting arch. *g.* Repairing linings, floor, and flues of ceramic kilns.	Ability to take out and replace burned out sections of arches and walls in which special shapes have been used.	.....	.....	.....	Trade terms: Crown	.....	Repetitive training in laying with a brick-to-brick joint firebrick walls on prepared vertical or horizontal flat surfaces. Laying up firebrick walls of regular and special shapes on the inside of circular walls. Laying and setting a self-supporting arch of firebrick under a brick self-supporting arch. Supporting work on the inside of a barrel arch. *Instruction required: Ability to repair sections of walls, arches, and floors in all types of industrial kilns, ovens, furnaces, and tanks.*

CONSTRUCTION JOBS

BLOCK–BL–V.—CONSTRUCTION JOBS IN BRICKLAYING CALLING FOR THE LAYING OUT AND LAYING UP OF BRICKWORK, USING A VARIETY OF MATERIALS

Block objective: Ability to carry through ordinary construction jobs in brickwork calling for a variety of operations and the use of various materials

Construction jobs	Blocks and jobs	Type jobs	General vocational information	
1. Brick foundation for frame house.	BL–I–12	Laying up walls with projecting or receding courses.	V. Drawing: 2. Reading working and setting drawings. VI. Science: 2. Some physical and chemical properties of brick. *c.* Brick and water. 3. Distribution of forces. *b.* By mortar and brick. 4. Types of construction. *b.* For protection from moisture.	VII. Mathematics: 4. Cubic measurement. *a.* Using tables to estimate number of brick and quantity of mortar in walls of varying thickness.
	BL–I–9	Building around right-angled openings.		
	BL–I–16	Laying up 13- or 17-inch inside walls, common bond, semifinish.		
	BL–I–13	Laying up 8-inch intersecting wall with or without openings.		
	BL–II–7	Outside or inside finished wall with projected or receding surfaces.		

BLOCK–BL–V.—*Construction Jobs in Bricklaying Calling for the Laying Out and Laying Up of Brickwork, Using a Variety of Materials*—Con.

Block objective: Ability to carry through ordinary construction jobs in brickwork calling for a variety of operations and the use of various materials—Continued

Construction jobs	Blocks and jobs	Type jobs	General vocational information	
2. Three-flue chimney with terra cotta flue lining.	BL–I–10 BL–III–2–b	Laying up 8-inch vertical wall, square corners, running bond, semifinish. Setting a chimney capping.	III. Materials of the trade: 4. Architectural terra cotta. *b*–6. Setting. IV. Details of construction. 6. Special constructions: *a*. Chimneys and stacks. *b*. Flues.	VI. Science: 5. Mortar. *a*. Behavior of various kinds of mortar. VII. Mathematics: 4. Cubical measurement. *c*. Estimating by use of tables number of bricks for chimneys or piers of various sizes.
3. Semicircular brick culvert under private driveway. A single-arch footbridge. Round cistern with beehive top. Brick manhole in sewer or conduit construction.	BL–I–17 BL–II–9	Turning a semicircular arch over an opening. Outside or inside finished work with projected or recessed portions calling for curved lines.	IV. Details of construction: 2. Supports. *a*. Footings. *b*. Arches. *d*. Piers. VI. Science: 3. Distribution of forces. *c*. By arches. 4. Types of construction. *b*. For protection from moisture.	VII. Mathematics: 5. Circular measurement. *a*. Laying out segments of circles.
4. One- or two-car garage with 8-inch wall, solid brick. One- or two-car garage, combination of brick and hollow tile, 8-inch, 10-inch, or 13-inch walls.	BL–I–9 BL–II–1 BL–I–15	Building around right-angled opening using iron lintel support. Laying up outside 8-inch wall with or without openings, using common brick, common bond, finished work. Building up an outside wall with or without openings, struck or weathered joint, with materials that determine wall thickness.	III. Materials of the trade: 2. Hollow building tile. *a*. Shapes and kinds. *b*. Sizes in comparison with brick units. IV. Details of construction: 3. Wall construction. *a*. Brick. *c*. Combination brick and hollow tile.	VII. Mathematics: 3. Surface measurement. *b*. Estimating areas by square measure. *d*. Estimating number of brick in areas like gable ends.
5. Porch with brick steps, floor, railing, and posts. Porch with brick balustrade and stone capping. Pergolas with brick floor and posts. Garden seats made of brick and cut-stone.	BL–II–11 BL–II–15 BL–III–4 BL–II–16	Outside or inside walls with projected or recessed panels having vertical or horizontal pattern arrangement. Laying up molded brick of any shape, placed in horizontal or vertical positions. Setting several pieces of cut-stone trim with end joints. Laying up all kinds of molded or ornamental brick in which plan is irregular or circular.	III. Materials of the trade: 3. Cut stone. *a*. Kinds of stone commonly used with brickwork. IV. Details of construction: 6. Special constructions. *d*. Porches. *j*. Walls and garden ornaments. V. Drawing: 2. Reading working and setting drawings.	VIII. Applied art: 2. Lines. *a*. Vertical and horizontal lines in brick construction and their relation to design. 4. Composition. *b*. Illustrations showing combinations of materials in design.

6. Fireplace with patent damper and firebrick lining Fireplace of hollow tile and brick with patent damper and firebrick lining. Setting and anchoring cut-stone fireplace facing.	BL-I-12 BL-I-11 BL I-17 BL-I-14 BL-IV-1 BL-II-7	Laying up walls with projecting or receding courses. Laying up an 8-inch wall and building around fittings. Turning simple arches over temporary centering. Laying up walls with materials that determine wall thickness. Laying up firebrick surfaces on brick walls. Outside or inside finished wall with projected or receding surfaces.	III. Materials of the trade: 1. Brick. *b.* Clays used in the manufacture of brick. 6. Mortars: *a.* Properties. IV. Details of construction: 3. Wall construction. *c.* Combination brick and hollow tile. 6. Special constructions: *a.* Chimneys and stacks. *b.* Flues. *c.* Fireplaces.	VI. Science: 5. Mortar. *a.* Behavior of various kinds of mortars. VIII. Applied art: 3. Surfaces. *b.* Mistakes in construction by the bricklayer that affect the balance and symmetry of design.
7. Baker's oven faced with enameled brick. Building a pottery kiln	BL-IV-1 BL-IV-2 BL-IV-4 BL-II-13	Laying up firebrick surfaces on brick walls. Laying up firebrick veneer against circular brick walls. Laying firebrick wall on inside of brick crown. Laying up straight surface with glazed brick, common bond.	III. Materials of the trade: 1. Brick. *a.* Kinds (burned and composition). *b.* Clays used in the manufacture of brick. *d.* Types of kilns. IV. Details of construction: 6. Special constructions. *g.* Kilns. *h.* Ovens.	VI. Science: 4. Types of construction. *a.* For insulating. VII. Mathematics: 5. Circular measurement.
8. Laying up brick and hollow tile facing on a steel-framed structure. Laying hollow tile floors on a fireproof-constructed building. Encasing with hollow-tile columns and beams of steel-frame building.	BL-I-15 BL-II-3	Laying up outside wall with or without openings with materials that determine wall thickness. Laying up outside wall with or without openings, using face brick with tile backing, finished appearance.	III. Materials of the trade: 2. Hollow building tile. *a.* Shapes and kinds. *b.* Sizes in comparison with brick units. IV. Details of construction: 3. Wall construction. *c.* Combination brick and hollow tile. 5. Fireproofing. *a.* Walls. *b.* Floors.	VI. Science: 3. Distribution of forces. *d.* By supports.
9. Interior glazed brick walls for stores and restaurants.	BL-II-14 BL-II-8	Laying up glazed brick of any special form in any position. Outside or inside work, both surfaces finished.	V. Drawing: 2. Reading working and setting drawings. VIII. Applied art 4. Composition. *a.* Materials and their use in creating design surfaces.	

BLOCK–BL–V.—*Construction Jobs in Bricklaying Calling for the Laying Out and Laying Up of Brickwork, Using a Variety of Materials*—Con.

Block objective: Ability to carry through ordinary construction jobs in brickwork calling for a variety of operations and the use of various materials—Continued

Construction jobs	Blocks and jobs	Type jobs	General vocational information	
10. Terra cotta store front backed up with brick or hollow tile.	BL–III–12 BL–III–10 BL–III–8	Setting terra cotta as a veneered surface anchored to any backing. Setting terra cotta trim calling for intersections and anchoring to surrounding wall. Turning an opening with a flat arch using architectural terra cotta anchored to any surface.	III. Materials of the trade: 4. Architectural terra cotta. *a.* Its uses. *b.* Process of manufacturing. IV. Details of construction: 2. Supports. *c.* Lintels. 4. Veneering. *b.* Architectural terra cotta.	V. Drawing: 2. Reading working and setting drawings. VIII. Applied art: 2. Lines. *a.* Vertical and horizontal lines in brick construction and their relation to design.
11. Memorial gateway combination brick and cut stone.	BL–II–8 BL–II–15 BL–III–4	Outside or inside work with both surfaces finished. Laying up molded brick of any shape in vertical or horizontal position with projected or recessed surfaces, finished work. Setting several pieces of stone trim with end joint.	IV. Details of construction: 6. Special constructions. *f.* Ornamental gateways. V. Drawing: 2. Reading working and setting drawings.	VIII. Applied art: 4. Composition. *b.* Illustrations showing combinations of materials in design.
12. Remodeling front of brick building, including cutting out old walls and building around window and door openings.	BL–I–20 BL–II–5 BL–II–11	Cutting out openings and building around frames in old or new semifinished work. Outside or inside finished wall with rectangular or vertical header border. Outside or inside finished wall with projected or recessed panels.	IV. Details of consrtuction: 2. Supports. *d.* Piers. 7. Alterations and repairs. *a.* Cutting out. *c.* Underpining. VI. Science: 3. Distribution of forces. *c.* By arches. *d.* By supports.	VII. Mathenatics: 2. Linear measurement. *a.* Measuring distances by rule or tape. VIII. Applied art: 3. Surfaces. *b.* Mistakes in construction by the bricklayer that affect the balance and symmetry of design. 5. Color and texture. *b.* Combinations of colored mortar and brick with its effect on surface appearance.

NOTE.—The references in the column headed "Blocks and jobs" refer to jobs as listed in the four charts on the analysis of the trade. For instance, BI–I–10 refers to Block I and type job No. 10, which is "Laying up an 8-inch vertical wall, with square corners, running bond, and semifinished appearance."

The references in the "General vocational information" column refer to the sections, topics, and paragraphs in the outline of a course of study covering these subjects. For example, IV. "Details of construction. 6. Special constructions. (a) Chimneys and stacks," has reference to the paragraphs on the discussion of chimneys as found under the topic on "Special constructions," in Section IV, page 68, "Details of construction."

GENERAL VOCATIONAL INFORMATION

In addition to the job information which the apprentice needs in doing the various jobs involved in bricklaying, there is a considerable amount of knowledge indirectly related to the trade that he should possess if he is to become a first-class journeyman. This additional information, which is discussed under such topics as "Materials of the trade," "Details of construction," "History of the trade," and "Applied art," is presented under the heading "General vocational information."

No attempt has been made to include in this discussion every factor relating to the trade of bricklaying in its various phases. However,

Figure 13.—Public arsenal and powder magazine, Williamsburg, Va., restoration.
The original building was constructed in 1714 on the public square and was enclosed by a wall at a later date. This restoration was built on the original foundation.

enough information is presented to give a clear picture of the bricklaying industry as a whole. Much of the material included, particularly that under the topics "History of the trade," "Materials of the trade," and "Economics of the trade," is of an informational nature and is intended only as a guide to the instructor in formulating his own description of the various topics suggested. The information presented under other headings discussed in the "General vocational information" outline, such as "Drawing," "Science," and "Mathematics," may be used as a basis for a laboratory text or a shop manual.

To show how an outline of this kind may be developed and used as a basis for a course of instruction for apprentices, information on the subjects of "Drawing," "Applied art," and "Materials of the trade," and "Details of construction" has been included in Section III,

"Suggestions for the Instructor," and a course outline built up from this information.

Following is an outline of the headings that might be used in preparing a text on general vocational information for bricklayers.

Introduction.
History of the trade.
Materials of the trade.
Details of construction.
Drawing.
Science.
Mathematics.
Applied art.
Industrial economics.

An outline of the information which might appropriately be included under these various headings is here presented in detail.

Suggested outline for course of study in general vocational subjects.

I. Introduction.
II. History of the trade:
    1. The early uses of brick—
        a. Dating back to early history of mankind.
        b. Historical references as to the use of brick.
    2. How the first brick were made—
        a. Early development of brick and pottery.
        b. Use of sun-dried brick.
        c. First fired brick.
        d. Recent discovery of Babylonian hard-burned brick.
    3. The status of the worker—
        a. Construction work carried on by captives.
        b. Gradual changes in the attitude toward the worker.
        c. The "golden age" of craftsmanship.
        d. The rise of the guilds and their effect on the status of the worker.
        e. Present status.
    4. Political and cultural rise and fall of countries traced through their public works—
        a. The trade as an essential factor in the development of a country.
    5. Rise and decline of apprenticeship—
        a. Early methods of indenturing and training.
        b. The industrial period and its effect on apprenticeship.
        c. Present conditions of apprenticeship in the trade.

6. Changes in the trade brought about by the introduction of new materials and changes in the methods of contion—
    a. Slight change in trade practice from earliest times.
    b. Trade standards improved by the development of new materials.
7. Development of trade from the colonial period to the present—
    a. Early colonial dwellings and historical buildings showing work of early tradesmen.
    b. Demands for permanent buildings and the effect on the bricklaying trade.
    c. Local manufacture of brick and its effect upon building construction.
    d. Increased demand for fireproof structures with resultant effect on the trade.

III. Materials of the trade:
1. Brick—
    a. Kinds (burned and composition).
    b. Clays used in the manufacture of brick.
    c. Various processes of manufacturing.
    d. Types of kilns.
2. Hollow building tile—
    a. Shapes and kinds.
    b. Sizes in comparison with brick units.
3. Cut stone—
    a. Kinds of stone commonly used with brickwork.
    b. Hand and machine cutting and finishing of stone.
    c. Composition stone and its method of manufacture.
4. Architectural terra cotta—
    a. Uses.
    b. Process of manufacturing—
        (1) Modeling.
        (2) Molding.
        (3) Coloring.
        (4) Glazing.
        (5) Firing.
        (6) Setting.
5. Composition blocks—
    a. Materials used and their manufacture.
    b. Process of insulating and fireproofing.

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6. Mortars—
    a. Properties.
    b. Manufacture of lime and Portland cement.
    c. Kinds.
    d. Sand.
    e. Special mortars.
    f. Coloring of mortar.
    g. Mixing of mortar.
7. Tools and equipnent—
    a. Scaffolds.
    b. Mortar mixing equipment.
    c. Tools of the bricklayer.

IV. Details of construction:

1. Bonds and mortar joints—
    a. Structural bonds.
    b. Pattern bonds.
    c. Types of mortar joints.
2. Supports—
    a. Footings.
    b. Arches.
    c. Lintels.
    d. Piers.
    e. Columns.
3. Wall construction—
    a. Brick.
    b. Structural tile.
    c. Combination brick and hollow tile.
    d. Pre-cast blocks.
    e. Combination of other materials.
4. Veneering—
    a. Face brick.
    b. Architectural terra cotta.
5. Fireproofing—
    a. Walls.
    b. Floors.
    c. Roofs.
6. Special constructions—
    a. Chimneys and stacks.
    b. Flues.
    c. Fireplaces.
    d. Porches.
    e. Doorways.
    f. Ornamental gateways.
    g. Kilns.
    h. Ovens, glass tanks.

i. Furnaces.
j. Walls and garden ornaments.
k. Columns.
l. Walks and paving.
m. Reinforced brick work.

7. Alterations and repairs—
a. Cutting out.
b. Patching.
c. Underpinning.
d. Cleaning.
e. Pointing.

8. Building codes—
a. Building code and committee reports.
b. Local building code rules.
c. Fire underwriters' rules.

V. Drawing:
1. Amount of drawing needed by a bricklayer.
2. Reading working and setting drawings.
3. Making sketches.

VI. Science:
1. Objective.
2. Some physical and chemical properties of brick—
a. Soft brick.
b. Hard-burned brick.
c. Brick and water.
d. Mortar and brick.

3. Distribution of forces—
a. By bonds.
b. By mortar and brick.
c. By arches.
d. By supports.
e. By reinforcing rods.

4. Types of construction—
a. For insulating.
b. For protection from moisture.
c. For construction.
d. For supports.

5. Mortar—
a. Behavior of various kinds of mortars.

VII. Mathematics:
1. Objective.
2. Linear measurement—
a. Measuring distances by rule or tape.
b. Measuring distances by brick and mortar unit.
c. Measuring vertical distances by story pole.

d. Estimating distances by reading table of heights of courses.

3. Surface measurement—
   a. Reading tables giving sizes of brick or other materials used in bricklaying.
   b. Estimating areas by square measure.
   c. Estimating areas by using table giving quantity of brick per square foot.
   d. Estimating number of brick in areas like gable ends.
4. Cubical measurement—
   a. Using tables to estimate number of brick and quantity of mortar in walls of varying thickness.
   b. Estimating number of tile in walls.
   c. Estimating by use of tables number of brick for chimneys or piers of various sizes.
5. Circular measurement—
   a. Laying out segments of circles.
   b. Determining center of circle.

VIII. Applied art:
1. Introduction.
2. Lines—
   a. Vertical and horizontal lines in brick construction and their relation to design.
   b. Poor construction of curved lines and their effect on design.
3. Surfaces—
   a. Poor construction of bond in brickwork and its effect on the general appearance of the surface.
   b. Mistakes in construction by the bricklayer that effect the balance and symmetry of design.
4. Composition—
   a. Materials and their use in creating design surfaces.
   b. Illustrations showing combinations of materials in design.
5. Color and texture—
   a. Color combinations in brickwork.
   b. Combinations of colored mortar and brick with its effect on surface appearance.

IX. Industrial economics:
1. Introduction.
2. Brickwork as a structural necessity.

3. Supply and demand and their effect on the wage scale.
4. Relation of bricklayer to other occupations.
5. Modern division of the crafts in the building trades.
6. Specialization in the building trades.
7. Relation of the worker to the public.
8. Relation of the public to the worker.
9. Associations of employers, employees, or manufacturers.
10. The bricklayers' obligation to society.

Figure 14.—A modern railway and highway bridge constructed of reinforced brickwork.

The brick facing of the exterior of this structure is done in a style that is true to the spirit of the brick masonry in the early colonial period in Virginia.

SECTION III

COURSES OF INSTRUCTION AND TRAINING

DEVELOPING INSTRUCTIONAL COURSES

In a previous section of this bulletin, the job specifications and the type jobs outlined in the job analysis charts are set up in the order of difficulty of doing them. The italicized statement in the extreme right-hand columns of the charts headed "Training progression," indicates the operations or jobs the apprentice will repeat in doing a particular job. There may not be a common agreement regarding the progressive order in which these job specifications have been arranged. The primary purpose of making the analysis is to provide an inventory of jobs to which the instructor or the committee concerned with apprentice training can refer in setting up a course of instruction.

Actual courses of instruction may be built up by using as a basis jobs listed in the job analysis charts. Accompanying each job specification is a statement of the closely related technical knowledge and auxiliary information—mathematics, science, and drawing—the apprentice should have in order to carry on the job effectively. This material is usually presented by the instructor at the same time and place as the job instruction. It will be noted that the outline of the information which should be presented under these subjects does not follow any logical order of arrangement but is merely a tabulation of disconnected facts which if used as the content of a course of instruction, would have to be arranged in logical order. The material presented under some of the subject headings, it will be noted, is not sufficient to serve as a basis for a distinct course.

There are at least two possible methods of assembling the material outlined on the charts into courses of instruction: (1) the "project method" under which the subject matter is organized around the job, and (2) the "subject method" under which technical and related information is organized into subjects.

COMPARISON OF THE TWO METHODS

There are a number of advantages in setting up a course of instruction under the "project method." When this method is used, the content of the related subjects to be taught, as well as the order in

which they are to be given, is based upon the type jobs to be covered in the instruction. This means that the closely related technical

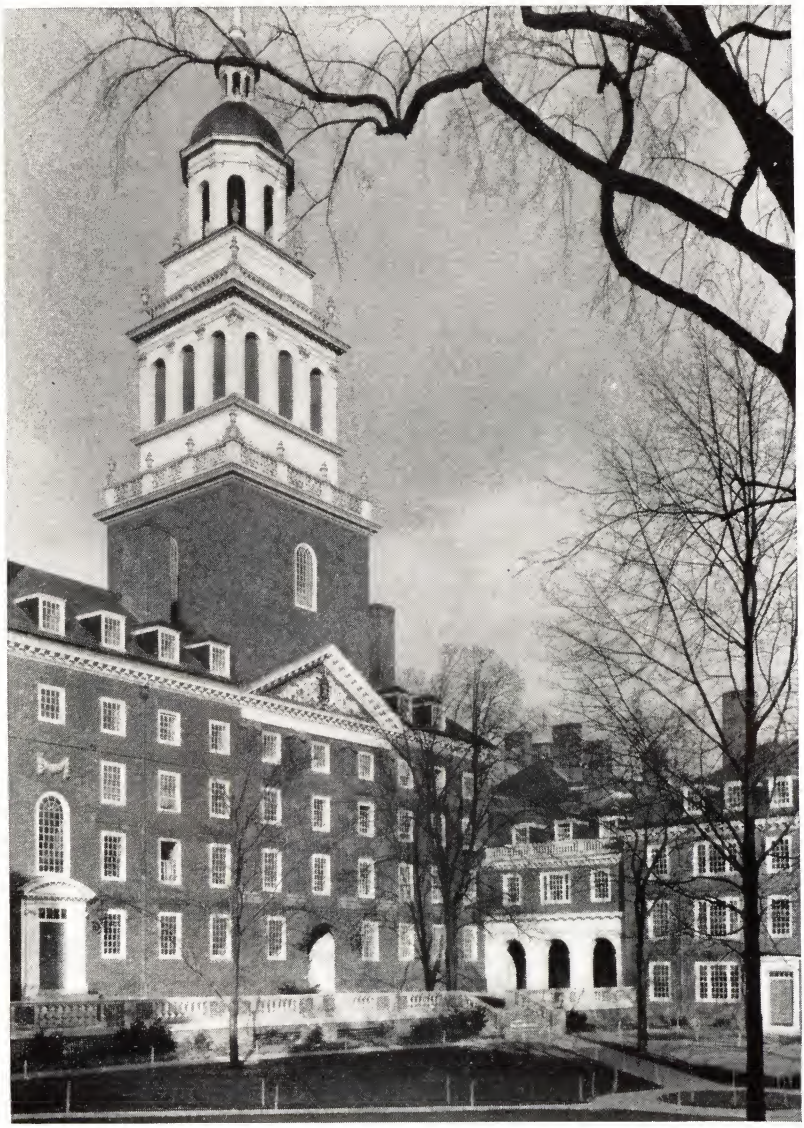

Photo by Willoughby

Figure 15.—Dormitory group at Harvard University, Cambridge, Mass.

Coolidge, Shepley, Bulfinch, and Abbott, architects.

knowledge and information will be given at a time when it is most needed and in a way that is most effective. For example: The squaring of a corner by means of the "3–4–5" device can be given

most effectively at the time when the squaring up of an actual corner requires the use of this device. Obviously, it is better to teach the mathematical principles involved in using the device, on the job rather than through make-believe examples set up in connection with a course in mathematics.

The "subject method" of organizing instructional material may be used to advantage when large groups of apprentices are to be trained, and when the related subjects may be grouped together and given by a separate instructor as a general subject, under some such title as "Shop knowledge". However, the analysis of the bricklaying trade indicates that there is not sufficient material available on the various related subjects to justify grouping them and offering technical knowledge or auxiliary information as distinct subject courses.

ARRANGEMENT OF DATA IN CHARTS

The jobs outlined in the charts are arranged in the order of difficulty of doing them. Jobs included under Block–BL–2, finished work, are based on the assumption that the apprentice has acquired, in doing the jobs listed in Block–BL–I, the knowledge and skill necessary in laying-up ordinary semifinished brickwork, and is, therefore, ready to be instructed in jobs requiring greater attention to appearance and finish. There are two possible methods of organizing the jobs included in the various blocks into a course of instruction. When conditions will permit, the best plan to follow is to offer the blocks in what may be termed a "series", taking up the jobs in the blocks in their serial order. Under this plan the jobs included in the first block are completed before the first type job in Block–BL–II is taken up. This is a logical plan to follow in arranging the material in a course of instruction.

To meet the conditions found in certain communities, it may be well to have the apprentices complete the jobs included in Blocks–BL–I and II in their respective order before they take up the jobs in Blocks–BL–III or IV. Some contractors may prefer their apprentices to advance to the jobs relating to the use of refractory material included in Block–BL–IV before taking up the jobs involved in setting terra cotta and cut-stone, included under Block–BL–III. This arrangement does not affect the continuity of the course, provided the jobs included under Blocks–BL–III and IV are completed by the apprentice before he takes up the jobs included in Block–BL–V.

The construction jobs listed under Block–BL–V are based on the knowledge and training secured in connection with the jobs included under the preceding four blocks.

GENERAL VOCATIONAL INFORMATION

Unlike the job technical information and auxiliary knowledge outlined on the charts, which it was suggested should be used in connection with the job instruction, the general vocational material should be used only in classes organized for instruction in these particular subjects. Definite courses based upon such subjects as the history of the trade and industrial economics, may be included as a part of the apprentice's training. Instruction in other subjects, such as drawing, materials of the trade, and construction details, may be arranged to supplement the job instruction. For instance, if the plan of organization calls for the giving of job and technical instruction on the job by competent journeymen instructors, the supplemental class instruction might include assignments from the material on "Vocational information".

LESSON ASSIGNMENT

As an example of the way in which general vocational subjects included in the outline on "General vocational information subjects" may be used as a part of the course of instruction on a particular job, the following suggested lesson assignment is presented:

Course of instruction—first year:

Job: Turning simple arches with common brick on 8-inch walls, using temporary centers—

Job Assignment Block–BL–I–17: Turning a bonded segmental arch over a door opening.

General Vocational Information assignment.

II. History of the trade.

7. Development of trade from the colonial period to the present.

IV. Details of Construction.

2. Supports.

b. Arches.

VI. Science.

3. Distribution of forces.

c. By arches.

TIME TO BE DEVOTED TO VOCATIONAL SUBJECTS

The time required to present "General vocational material" will not be as great as might be expected. The quantity of information to be included may be given effectively in 150 hours per year over a 4-year period, provided the material is properly organized and the instruction is efficient. Subjects requiring laboratory or drafting room instruction, such as drawing, details of construction, mathematics and science, will require additional time. The following schedule will

serve to indicate the place in the instruction program where the subjects listed under the heading, "Suggested vocational subjects" can be best given, and the probable hours necessary for each subject:

	Hours
First year:	
Materials of the trade	75
History of the trade	15 to 25
Details of construction	50
Second year:	
Drawing and blue-print reading	80 to 100
Mathematics	25 to 50
Science	25
Third year:	
Drawing	80 to 100
Mathematics	50 to 60
Details of construction	25
Fourth year:	
Applied art	25
Industrial economics	25
Drawing	50
Details of construction	50

TRAINING COURSES ARRANGED IN PERIODS

In outlining a 4-year course in job training, it is best to divide it into periods of 6 months and to organize the instruction material to correspond with this arrangement. A total of 58 job specifications are listed on 4 of the 5 job analysis charts: 20 in the first block, 16 in the second, 17 in the third, and 5 in the fourth. In addition, 12 suggested construction jobs are listed under Block–BL–V. Job specifications are listed, therefore, for a total of 70 jobs.

Figure 16.—An interesting combination of materials including common brick, cut limestone, and ornamental wrought iron.

The wall is laid up with rough textured common brick using wide mortar joints. The stone balusters vary in design. This illustrates the effective use of common brick masonry as a background for ornamental features made of other materials.

There can be no sharp division with respect to the jobs to be included in each instruction period. The 20 type-jobs in Block I may take longer to complete than the 5 type-jobs in Block–BL–IV but it must be remembered that the skill required to handle the jobs in Block–BL–IV would be acquired in doing the jobs in the first 2 blocks.

It is impossible to state how much time will be required for the job training. The course of instruction should be arranged in periods of 6 months each and should consume as much time as is required to accomplish the block objective outlined at the top of the chart in connection with the analysis for each block. The ability to do the jobs listed under each block up to the standard set up in the job analysis charts, will determine the time required for job instruction.

It is commonly accepted by the bricklaying trade that an apprentice should be able at the end of his first year, to do any common brick job in which the finished appearance of the work is not important. Below is a suggested arrangement which may be followed in planning a course of job instruction:

First Year: All of Block–BL–I—Semifinished work.
Second Year: Part of Block–BL–II—Finished work.
Third Year:
Balance of Block–BL–II—Finished work.
Part of Block–BL–III—Terra cotta and cut-stone trim.
Part of Block–BL–IV—Refractory materials.
Fourth Year:
Balance of Block–BL–III—Terra cotta and cut-stone trim.
Balance of Block–BL–IV—Refractory materials.
Block–BL–V—Construction jobs.

COURSES FOR JOURNEYMEN

Some of the material suggested under the heading "General vocational information" could be used as a basis for class instruction for groups of journeymen. Courses covering such subjects as the reading of drawings or construction details could be offered in evening classes.

SUGGESTIONS AND CAUTIONS

One of the common errors of the trade instructor is to attempt to give instruction by the telling and showing method. This is contrary to one of the fundamental principles of trade teaching which recognizes that the apprentice acquires knowledge and skill only through actually doing the work himself. Telling him how to do the job or showing him how it should be done will not accomplish proper results unless he is given an opportunity at once to try out for himself what he has been told or what he has been shown.

It will, of course, be necessary in teaching most jobs for the instructor to do more or less demonstrating; that is, to do some of the work himself. For instance, in the first job in Block I on "Backing-up," it will be necessary to show the apprentice how to handle a trowel and pick up and spread mortar since these processes must be understood by the apprentice before he lays the first brick. It should not be

necessary, however, to do as much demonstrating in the later jobs if properly worked-out instruction sheets are placed in the hands of the apprentice. There may be exceptions to this procedure, however, when an apprentice fails to understand just how to do the job from the directions as given by the instructor. It is then necessary for the instructor to assist the apprentice by demonstrating just what the directions are intended to convey.

Another common mistake of the instructor is to do too much demonstrating and not to allow enough practice on the part of the apprentice. Still another fault which is rather common among instructors is to use a wrong method of approach in correcting a learner who has made a mistake. It is much better from a teaching standpoint to lead the apprentice to discover the mistake and make the correction himself. This the apprentice will often do if given time. If, however, he fails to discover his mistake the instructor should use an indirect method in calling his attention to the poor work. For instance, if a learner is laying up his first job which consists of backing up a face wall header high and fails to make the top of his course come out even and level with the face, the following questions might be asked by the instructor:

Figure 17.—An early type of colonial store building, Williamsburg, Va., restoration.

A typical example of colonial brickwork in combination with white-painted wood trim.

> What is the purpose of the backing-up course?
> What happens when too much mortar is used in the bed course?
> Will additional courses be laid on top of this course?
> Must the last course be even and level with the front wall?
> How are you going to tell whether this is even and level with the top?

These questions may lead the learner to the point where he will sight along the top of the wall to see if the backing-up is level with the face. If so, the instructor has accomplished his purpose by leading the learner to discover his own error and to think out for himself a way of avoiding the same mistake in the future.

Telling the learner to tear his work down and lay it up again is permissible if he is doing a job on which he has previously received

instruction and the instructor knows that he is capable of doing better work. The instructor in this instance would be acting as a supervisor and not as an instructor.

The bricklaying apprentice has an opportunity to secure considerable repetitive training in doing each of the succeeding jobs in any of the blocks included in the job-analysis chart. The training leading up to the succeeding type-jobs in the series involves a continual repetition of the experiences learned in previous jobs. In Block–BL–I

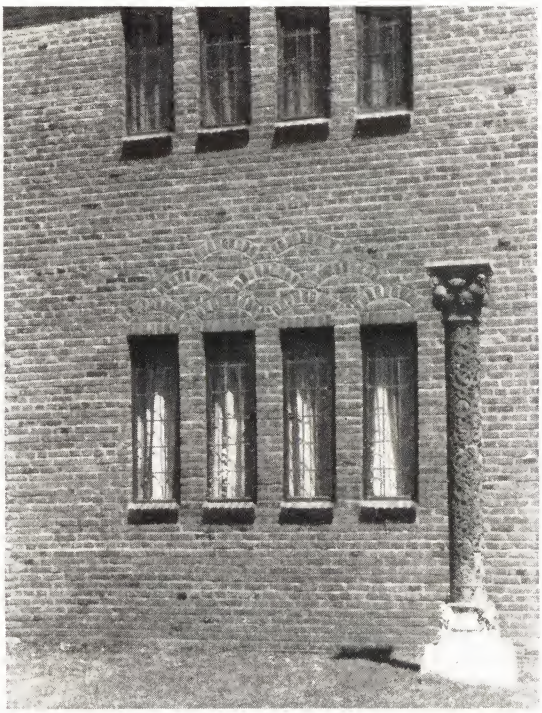

Figure 18.—Detail of wall, Cranbrook School of Art, Cranbrook, Mich.

An interesting pattern has been developed in the wall by the use of rough brick laid up in common bond The window sills are formed of projecting rowlock courses of headers and flush rowlock courses of headers are used for the lintels and relieving arches.

there is a repetition of the operations involved in laying up common brick in places where there is no particular need to pay attention to the finished appearance of the work. The apprentice acquires considerable training in handling brick and mortar and in laying up the common bonds used on inside work. Much of this training is carried over in Block–BL–II where considerable attention must be given to the finish of the work. The processes or operations involved in spreading mortar and handling brick on jobs included in Block–BL–II are the same as those in the jobs in the first block, except that more attention must be given to the finish of the joints and to the appearance of the completed wall.

Section IV

SUGGESTIONS TO INSTRUCTORS

THE INSTRUCTOR'S JOB

The courses of instruction outlined in the previous section should be given by a journeyman instructor who is thoroughly versed in the trade of bricklaying and who knows how to teach. It is impossible in this bulletin to take up in detail the subject of trade teaching, but a few suggestions are offered which may help the journeyman instructor to avoid the mistakes commonly made by mechanics when they attempt to instruct others in the theory and practice of their trades.

The instructor must realize at the beginning of his teaching experience the distinction between a production job and a teaching job. As a journeyman worker he has been concerned in producing a finished piece of construction that will meet the standards of the trade. In accomplishing this end he has made use of the knowledge and skill he has gained through years of experience as a worker at the trade. As a journeyman instructor his job is to impart his trade knowledge and skill to the apprentice or learner. In doing this the journeyman must make use of the instruction methods or "teaching tools" employed by competent teachers.

The objective of the instructor should be to produce well-trained apprentices. The efficiency with which the instructing job is carried out depends upon the ability of the instructor to impart the theory of his trade and to stimulate the apprentice to acquire skill in the trade.

It should not be inferred from the preceding statement that it will be necessary for a journeyman to spend years in training to become efficient in instructing apprentices. Experience has shown that it is possible for a first-class mechanic to acquire the more important points of teaching within a short period of time. It is possible in every State for the journeyman to secure training in instructing apprentices through free evening or extension instructor-training courses, carried on by State boards for vocational education.

THE INSTRUCTING PROCESS

The instructing process, as it is used by trade instructors, consists of four operations or steps carried through in a definite order.

These steps or instructing operations are as follows: Step 1, preparation; step 2, presentation; step 3, application; and step 4, testing or inspecting. The purpose of step 1, preparation, is to get the apprentice interested in what is to be taught; of step 2, presentation, to give the instructional material in detail; of step 3, application, to give the apprentice experience in performing the operations being taught, and to give the instructor an opportunity to emphasize any points that the learner may not have acquired in step 2; and of step 4, to test the apprentice and make sure that he has learned what was presented in the lesson.

Each lesson given by the instructor should be so organized that it may be presented to the apprentice in the order suggested. The instructor can acquire a better understanding of the functions of the four teaching steps through the study of a text on trade teaching, or, better still, by attending, as suggested, one of the evening instructor-training courses. The purpose of presenting the instruction process here is to call the attention of the instructor to the fact that trade and related instruction is based upon a definitely organized procedure.

JOB TRAINING

There is only one way in which efficient job training may be given; that is, by bringing the learner and a competent instructor together. No book, lesson, or job sheets can take the place of the instructor who knows his trade and has ability to instruct. Instruction may be given in two ways: (1) By preliminary demonstration, and (2) by instruction on the job.

Instruction by preliminary demonstration.—In following this procedure, the instructor first does enough of the work himself to show the learner how it is done. He then allows the learner to do the work, watching and correcting him, and giving him further information on special points, if necessary.

Instruction on the job.—When instruction is given on the job, the preliminary demonstration is omitted and the learner is required to perform the job under oral directions or with the aid of a set of directions or a job sheet. The job sheet outlines the successive job operations and contains additional information on how to perform the job. When the learner comes to the point where he needs to learn a particular operation, the instructor demonstrates how this should be done and checks the learner to see if he has acquired the proper skill and knowledge.

THE JOB SHEET

The job sheet is a time-saving device for the instructor, in that it gives the apprentice information he can use on the job. Skill cannot be taught by any form of written description. No job sheet can take the place of the qualified instructor. The most satisfactory job sheets

are those prepared by the instructor himself, and it is doubtful if, under the varying conditions incident to the bricklaying trade, standard sheets which would fit all conditions could be prepared.

Some job sheets contain illustrations or diagrams showing how the work progresses from one step to the next. Others include an introductory statement outlining the nature of the job, and the relation the job bears to the completed structure, as well as detailed directions to aid the apprentice in doing the job. At the end of the job sheets there are usually a number of questions bearing directly on the work that has been done in completing the job. In order to answer these questions it is necessary for the apprentice to draw on the knowledge he has gained in doing this particular job or those preceding it.

Job sheets should be printed or reproduced by some duplicating process.

TEACHING THE LESSON

The instructor should realize that the instruction job must be divided up into small parts and each part presented separately as a distinct lesson. This procedure makes it possible for the apprentice to demonstrate that he has completed the lesson section by section and is ready to receive further instruction. It will be necessary for the instructor to have clearly in mind what he is going to teach and the order in which he is going to teach it. This makes it highly desirable that the instructor work out a plan of procedure in advance. Such a procedure will greatly assist him in planning the steps he will follow in instructing.

SAMPLE JOB INSTRUCTION SHEETS

Included in this section of the publication are suggested job instruction sheets for the first and second jobs included under Block–BL–I and Block–BL–III, as well as the outline followed in making up the instruction sheets.

The outline used in working out the job instruction sheets is as follows:

1. Heading giving key to type-job on chart.
2. A preliminary statement giving the nature and purpose of the particular job.
3. Information on doing the job.
4. Related technical information, such as information on safety on the job, trade technical drawing, and mathematics.
5. Cautions.
6. Questions.

The purpose of the job sheets presented in this bulletin is to show the form in which such sheets may be arranged. The details shown

on such sheets will of course vary with the current practice of the bricklaying trade in different parts of the country. Since these job sheets are merely examples to show the plan of arranging such sheets, no attempt has been made to have the directions given conform accurately to trade practice in any one section of the country.

Job Instruction Sheet

Block–BL–I.—Semifinished work.

Job Specification 1.—Backing up with common brick using common bond against a vertical wall between established vertical ends not over the length of six brick.

Type-job *b*.—Backing up the face of an 8-inch wall between window jambs using common brick.

PRELIMINARY

In this particular job the wall to be backed up is not over 4 feet long and the ends are laid against an upright frame. The brick are also laid up against the inside of a face wall in order that the wall may be strengthened. This is one of the first jobs given to an apprentice because it is not necessary that the work be as carefully finished as the work on an outside job. Even though the wall is covered it is necessary that the courses be laid up level and that the top course be even with the face of the wall.

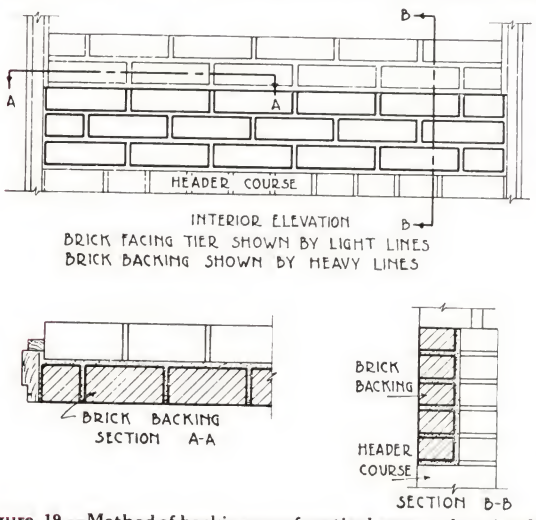

Figure 19.—Method of backing up a face tier between door jambs. Section A–A shows bed course with closure brick against jamb. Section B–B shows the header course and brick backing.

1. Finding number of brick needed for the course.

There are two methods of determining the number of brick needed to fill a particular space: (*a*) By counting the brick in the face wall, and (*b*) by laying the brick out dry.

a. The method of counting brick in the face wall course is used because the face and backing brick are practically the same size. If a part of a brick is needed to fill out between the two uprights, it will be necessary to cut a piece of brick to finish out the course.

b. The second method of laying the brick out dry consists of starting at one end and placing the brick on the wall, using the tip of the forefinger to space the distance between the ends of the brick.

2. **Keeping the course straight.**

a. Lay the two end brick level with outside course and fill in the balance of course. Check with a straight edge to see if top and sides of brick are in line. Your instructor will demonstrate how to pick up, or "cup," and spread mortar.

b. Another way to keep the course straight is to lay to a line the ends of which are fastened to window or door jambs which are flush with the inside wall. This line should be fastened at the height of the outside course.

3. **Laying the second course.**

If you have started the first course with a whole brick, start the second course with a half brick and lay the remaining brick so that they overlap by one-half their length the brick in the lower course.

4. **Checking.**

If the course has not been laid to a line, it will be necessary to check with straight edge to see if the brick are level and in line.

The better method would be to lay the course to a line which will not only keep the brick in line but will also keep the course level. Your instructor will demonstrate the proper method of raising the line and fastening it to uprights or established ends.

5. **Laying the third and succeeding courses.**

a. Repeat the same operations you followed for the first and second courses. As shown in Fig. 19, the brick in the alternate courses are laid up directly over each other.

b. Continue laying courses to height of outside tier, being sure that you come out even and level with the face tier.

CAUTIONS

1. Keep pieces of brick out of the mortar.
2. Keep mortar rounded up on board to prevent lumpy mortar.
3. Keep floor clean under your feet.
4. Do not use too much mortar.
5. No mortar should be placed between end of brick and the uprights.
6. Do not crowd end uprights.

QUESTIONS

1. *What will happen if you crowd the brick against the upright?*
2. *What is the hardest thing to do on this job?*
3. *Does it make any difference how thick your end joints are?*
4. *What kind of a bond are you using?*
5. *Why do you alternate the piece at each end?*
6. *Which joint is the most important?*

Job Instruction Sheet.

Block–BL–I.—Semifinished work.

Job Specification 2.—Backing up with common brick, hollow tile, or precast blocks against a vertical wall between established ends for any length over six brick. Surface appearance of finished wall is not important.

Type-job *a*.—Backing up an 8-inch wall between two door frames.

PRELIMINARY

This second job differs from the first job in that the distance which has to be filled in between the two vertical jambs is greater. On the first job you kept your courses even and and in line by sighting along the joints in the face wall. However, in this second job you will learn how to lay up leads and how to lay to a line.

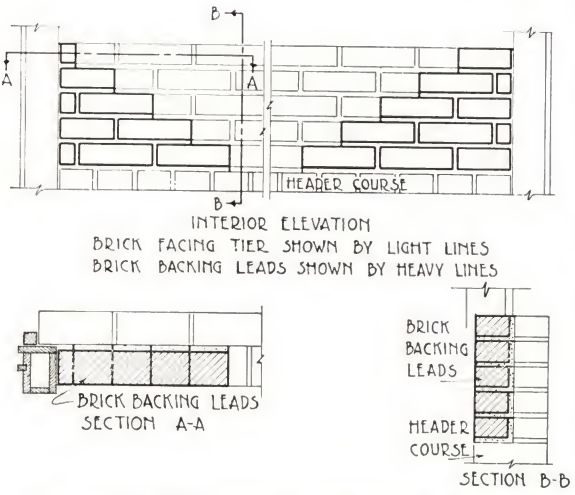

Figure 20.—Method of laying up leads on the inside of an 8-inch wall.

1. **Laying up a lead.** Laying up a lead (see Figure 20) is the bricklayer's method of keeping the courses in the wall straight and at the same level. A lead is always used in starting a wall. The lead usually consists of a first course of three brick. Each succeeding course is stepped back the length of a half brick, and when finished the lead is six courses high.

a. Laying out dry: Place and adjust the brick for the total length of the distance as you did in the first job. After properly spacing lay the brick to one side.

b. Laying the first course: Lay the first course in mortar the same as you did on the first job.

c. Laying the second course: Having laid the first course with a whole brick, it will be necessary to use a half brick to start the second course.

d. Completing the lead: See that the brick that you have just laid are even and level with the face wall. Lay the fourth course, which will be a brick and a half in length. Use the straight edge or plumb to straighten the face of the wall. Ask the journeyman to whom you are responsible if your lead will pass inspection.

2. **Laying the lead on the opposite end.**

a. Determine how you are to start the lead.

b. Lay the first course two and a half or three brick in length, the same as you did in the first lead.

3. **Completing the second lead.**

Continue laying the second, third, and fourth courses, stepping back each course a half brick the same as you did on the opposite lead. Use the plumb rule to straighten up this lead.

4. **Checking up.**

See if the courses in the two leads are in line with the face wall and if the leads are level and straight. Ask your instructor if this second lead will pass inspection.

5. **Stretching the line.**

It will be necessary to have your instructor show you how to fasten properly, place in position, and stretch a line between two leads.

6. **Laying to the line.**

a. Spread the mortar for two or more brick. See that the brick is laid exactly even with the line and does not touch it in any place.

b. Cut off mortar and place the cross joint.

7. Unfasten your line from the nail or other fastening on the left hand. Raise the line to the second course. Stretch the line and fasten on the opposite side and finish the second course between the two leads. Repeat this operation from course to course until lead is laid up.

8. Checking up.

Sight down the side of the wall to see that there are no projecting brick.

It will be necessary on this job for you to learn from the journeyman how to properly start a lead, how to level and plumb, how to properly fasten a line, how to stretch the line, and the proper method of "cupping" and picking up mortar.

CAUTIONS

1. Do not crowd the line.
2. Be sure to keep the courses in the leads level.
3. Keep the line rolled up, when not in use, and free from mortar.

QUESTIONS

1. What will happen if you crowd the line?

2. Why is it necessary to have the face of steps or "tailings" in the lead in line?

3. Which lead was more difficult to lay up?

4. Why is it necessary to have bed joints the same thickness in both leads?

5. What will happen if your brick are not placed level in the leads?

Job Instruction Sheet

Block–BL–I.—Semifinished work.

Job Specification 2.—Backing up with common brick, hollow tile or precast blocks against a vertical wall between established ends for any length over six brick. Surface appearance of finished wall is not important.

Type-jobs *c* and *d*.—Backing up between openings using precast blocks or structural hollow tile.

PRELIMINARY

Material other than brick, such as concrete blocks and hollow tile are used for backing up an 8-inch wall. This material acts as an insulator for exterior walls and because it is made in larger units can be laid up more quickly than other backing material. Either tile, concrete, or cinder blocks are of a size which allow for cross bonding at every seventh course. Figure 21 illustrates the method of laying hollow tile on its side in backing up an 8-inch wall. Tile laid up in this manner makes a solid bed for the bed joint.

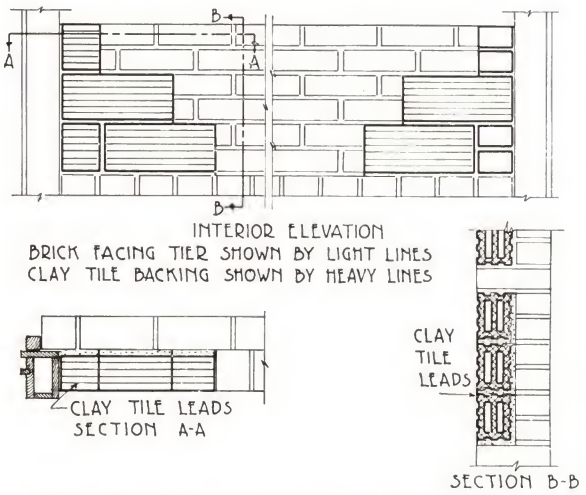

Figure 21.—Hollow tile leads laid on side in backing of an 8-inch wall.

Section B–B shows the hollow cells in the tile and also indicates that three courses of tile are equal to six courses of brick. The back of the face tier is often parged to make the wall watertight. This is shown in the cross section A–A. Figure 22 shows precast blocks made with vertical cells. Section B–B of the drawing shows that two courses of blocks are equal to six courses of brick.

1. **Laying out blocks dry to determine size of leads.**

Space blocks along the wall allowing for ample cross joints and find out what length block will be required at opposite end.

2. **Laying up leads.**

Lay up a two- or three-course lead at each end. The window or door jambs serve as guides when the finished wall is to be flush with back of jamb. The mortar is spread on these larger units in the same manner as on brick. The blocks are buttered for cross joint.

3. **Stretching line.**

Stretch line on top of first course from lead to lead and fasten at

ends by means of nails or blocks. Figure 21 and figure 22 show hollow tile and precast block leads laid up to header height.

4. Laying up to header height.

Raise the line for the next course and continue to raise the line from course to course until tile is laid up to header height.

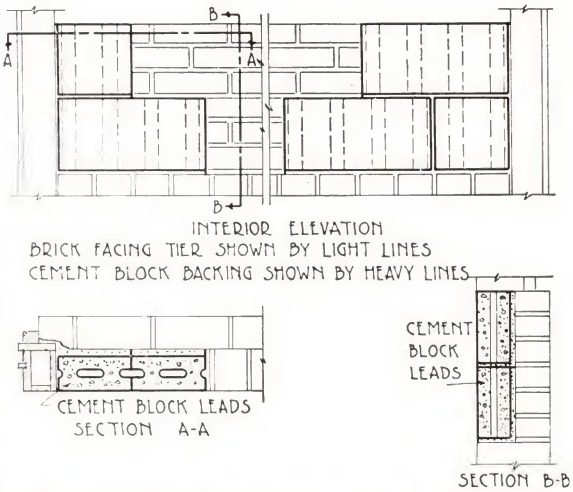

Figure 22. Precast cement blocks used as backing of an 8-inch wall.

Section A–A shows the back of the face tier parged with mortar.

CAUTIONS

1. All units used for backing should have as full cross joints as possible.

2. Do not place mortar between the block or tile and the wood jamb.

3. It is better to use brick for certain spaces than to attempt to spread or crowd the larger units.

QUESTIONS

1. Why are large units preferred over brick as a backing up material?

2. How many courses of brick are there between headers when large units are used for backing?

3. What are the common sizes of 4-inch structural hollow tile and precast units?

4. Of what use are the cells in these large backing units?

Job Instruction Sheet

Block BL I.—Semifinished work.

Job Specification 3.—Backing up with common brick, using common bond against a vertical wall between an established end and a corner wall of any length. Surface appearance not important.

Type-job *b*.—Backing up an 8-inch wall between window or door frame and inside corner.

PRELIMINARY

The outside corner having been laid up to header height with common bond, your job now is to lay up an inside corner and to fill between the corner and the door jamb. Since this is to be a semifinished job, the joints in the backing are struck with a trowel. Figure 23 illustrates the method of laying corner leads to header height. The distance from corner to jamb can be greater than illustrated on the drawing.

1. **Laying up inside corner lead.**

Lay out a sufficient number of brick in first course on each side of corner to make leads header high when completed.

2. **Plumbing and ranging inside corner.**

Use plumb rule for plumbing inside corner and for ranging the tailings.

3. **Running out courses from corner to jamb.**

Because of the short distance from the corner lead to the jamb, it is advisable to use a line or plumb rule in checking each course.

CAUTIONS

1. Break joints in the angle of the first course so as not to have two vertical joints over each other in succeeding courses.

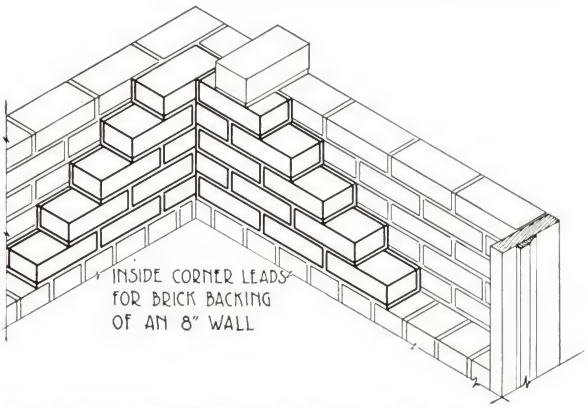

Figure 23.—Inside corner of an 8-inch brick wall laid up in common bond.

2. Level all courses when laid. If necessary, use short level for this purpose.

QUESTIONS

1. Why is it necessary to have backing level with outside tier?

2. Why do you tail out a certain number of brick on the first stretcher course?

3. Are plumb vertical joints important on the job?

Job Instruction Sheet

Block–BL–I.—Semifinished work.

Job Specification 14.—Building up inside walls, not over 8 inches in width, using material that determines wall thickness.

Type-job *b*.—Laying up a partition wall with lime, gypsum, cement, or hollow tile blocks with openings not over 4 feet in width.

PRELIMINARY

Inside walls that are not load bearing may be laid up with precast blocks or fired masonry material. Hollow tile is one of the materials

used for partition walls between rooms. It is laid from floor to ceiling in fireproof types of buildings. The material has a certain fire resisting rating standardized by the Underwriters' Code. The kind of material which may be used for a particular purpose is specified in local building codes.

In this particular job you are to use 8-inch hollow partition tile to lay up the wall on both sides of a doorway in which the door jamb has been set in place and the tile to be used is 8 inches by 12 inches by 12 inches, molded with 6 cells.

It is to be laid upright—end type of construction.

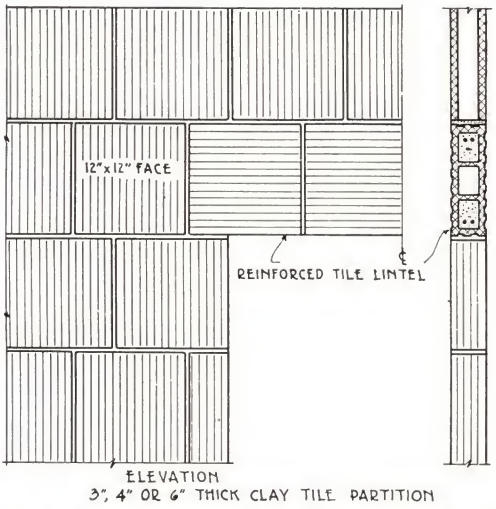

Figure 24.—Elevation and section views of a 3- or 4-inch tile partition wall.

A lintel has been made up with reinforcing rods in top and bottom cells of the tile.

1. Laying out tile dry.

Laying out the tile from the door opening to the wall on each side allowing space between the tile of at least one-half inch for cross joints.

2. Laying up leads.

a. Determine position of partition in relation to the door jamb, which is set in place by the carpenter.

b. Lay up a 3-course lead at both ends of the partition.

3. Laying up first course.

a. Stretch the line from lead to lead on first course. It is advisable in laying up large clay units to stretch a secondary line about 2 inches above the bed of the first course. This line serves as a guide to keep the tile plumb and in range. It is to be used only in laying up first course.

Figure 25 illustrates the method of buttering cross joints with a full joint of mortar before the tile is laid in the wall and figure 26 shows the position of the door frame in a partition wall. It will be noted that the frame is braced so as to keep it square and of proper width.

b. Start from either lead and fill in first course.

4. Cutting tile to fill space.

If necessary, cut a tile to fill a space at jambs. The cut edge of the tile should be placed against the adjoining tile rather than in contact

with door jamb. When this is done it is not necessary to use mortar between tile and door jamb.

5. **Anchoring jamb to tile.**

Place anchors in mortar joints.

NOTE.—If wood buck is used 20d nails should be driven into the buck and bent over into the web of the tile so as to anchor jamb into wall. If metal bucks are used metal ties or other fastenings are supplied with the jamb to lay in mortar joint.

6. **Laying up wall.**

a. Continue raising the line and repeat the operations described in laying up first course.

b. Finish to proper height.

Figure 24 illustrates the method of laying up a 3-inch or 4-inch hollow tile partition wall with reinforced tile lintel over opening.

Figure 25.—Cross joint of backing tile being buttered with mortar before laying in wall.

CAUTIONS

1. Do not allow mortar between tile and wood jamb of a door or window frame. In laying cut tile place molded edge against frame.

2. Be sure that mortar is of proper consistency for spreading to the best advantage on the outer webs of partition tile.

3. See that face of jamb lines up with both leads.

4. Check jambs to see that they are plumb and square.

5. Do not remove braces from their original position on door or window frame.

QUESTIONS

1. Why are two lines used for laying the first course of tile?

2. Why is a full cross joint of mortar required for end construction?

3. Why should mortar be of the proper consistency when spreading bed joints?

Figure 27 illustrates the use of precast cement blocks in a partition wall. A precast concrete reinforced lintel is used above the opening.

Job Instruction Sheet

Block BL–I.—Semifinished work.

Job specification 16.—Laying up an inside 13-inch or 17-inch brick wall using common bond.

Type-job *b*.—Backing up cut-stone facing of exterior load-bearing wall.

PRELIMINARY

The wall to be laid up in this job has a total thickness of about 23 inches. It consists of a 6-inch stone facing with 10-inch bond stone and two full stretchers in the brick backing. The customary practice in laying up walls of this type is to leave a ½-inch space for mortar joints between stone facing and brick backing.

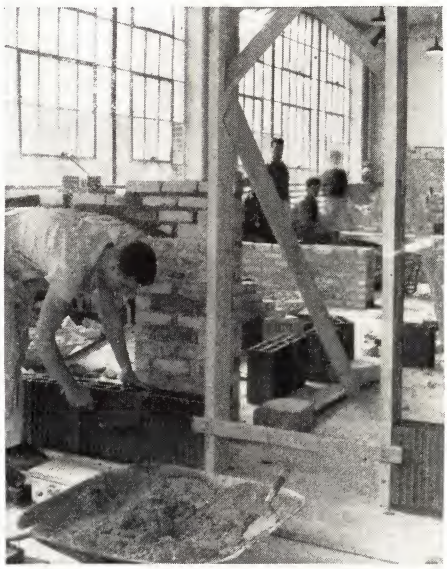

Figure 26.—Door buck shown in this photograph has been set in place and first course of tile started on each side of jamb.

This wall is to carry the loads of floor and roof construction as well as its own weight; it is important, therefore, that it be laid up in a substantial manner, having bed and vertical joints filled with a good mortar that will provide both high compressive and bonding strength. Since the brick backing is to be laid in a cement-lime mortar, the back of cut

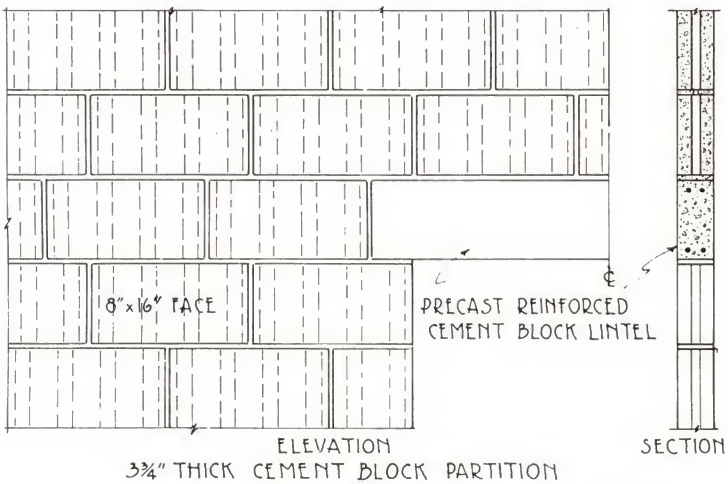

Figure 27.—Elevation and section views of a cement block partition with a reinforced precast concrete lintel over the opening.

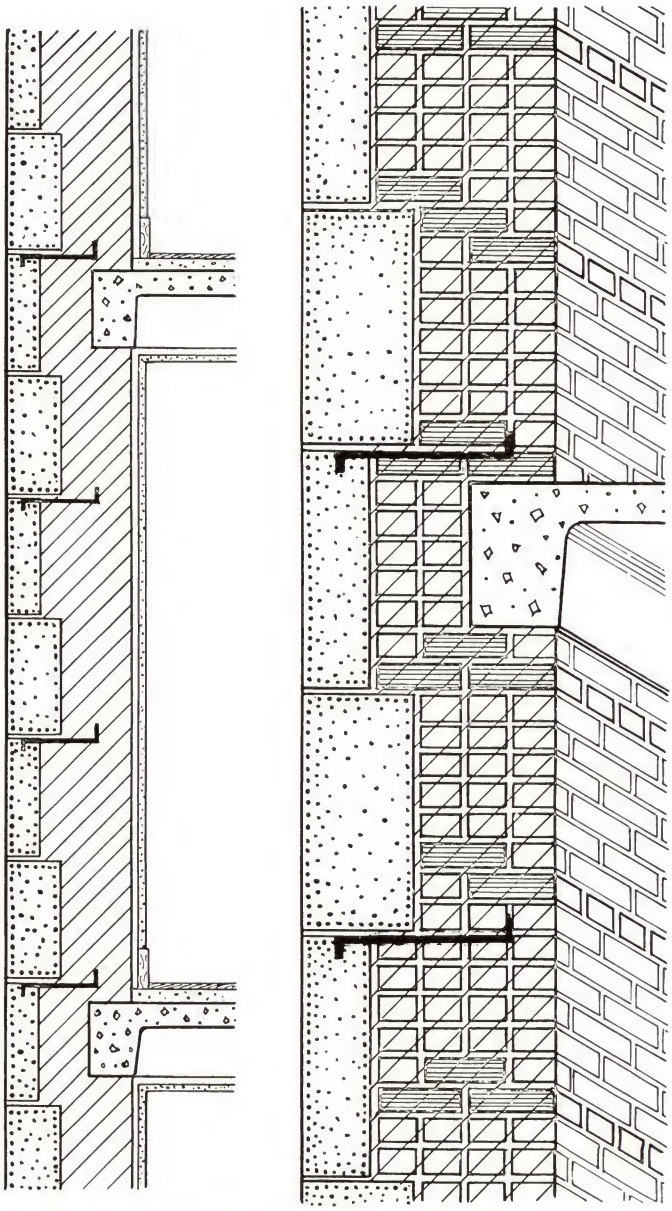

Figure 28.—Section of load-bearing wall showing stone facing bonded and anchored to brick backing.

This drawing also shows the method of bonding brick backing in wall supporting reinforced concrete floor construction.

stone will be parged by stonesetters with the mortar used for setting cut stone, before the backing is laid up. Also in work of this character, the bricklayer will help the ironworker in setting the loose steel that will form the support for lintels over window and door openings and will assist the carpenter in setting the wood centers required for turning the brick relieving arches built in back of the stone lintels over openings.

The bricklayer will also be required to build the chases in the walls called for on drawings. These chases or openings are used to conceal the installation of pipe risers and other mechanical equipment needed for servicing the building. Since this is a load-bearing-wall type of construction, both the bricklayer and the stonesetter will carry the walls up only one story in height and then wait for the setting of floor beams and building of floor construction before proceeding with the walls for the next story. This form of construction is used for buildings that are only 2 or 3, or at the most, 4 stories in height above the basement.

In many respects, this job does not differ greatly from the job of laying up rough load-bearing brick walls, experience in which was provided in connection with previous jobs, except that the openings are established by the stonesetter and hence do not have to be measured and located by the bricklayer.

1. Laying off brick course heights.

The object of this operation is to give the apprentice experience in working out a course height spaced so that the brick courses will come out even with the top of the stone facing. This can be accomplished by making the mortar bed joint either a little thicker or thinner than usual. It is important that backing come out level with bond stone.

2. Setting gage boards and stretching the lines.

Set gage boards about breast high at corners and at all intersecting interior walls. Stretch lines to conform with the dimensions shown on architect's drawings.

3. Laying up first course.

Plumb down from the previously established lines to locate corners, intersections, and other openings. Lay out first course to determine the general scheme of bonding to be used in laying up the wall. Chases should be provided for in laying out the first course. Similarly when a pilaster is to be built into the backing for the support of girders, it should be correctly located in laying out the first course.

4. Laying up the leads.

Build up leads at the corners and at all intersecting cross-walls. In laying up walls of this character the brick should be buttered on outer face and end, and be shoved into a full bed of mortar.

5. **Filling in between leads.**

First lay the brick course in contact with the back of stone facing, followed by the brick course that forms the inside face line of walls. Fill in the remaining tiers between backing and inside face tier.

6. **Laying headers.**

When six complete courses have been laid up, a header course is laid, bonding both inner and outer half of wall. Lay a second header course in the middle half of wall to bond together the two sections of the wall. Figure 28 shows method of bonding the several tiers forming the backing.

As each level of bond course is reached, the bricklayer works on some other part of the wall while the bond stone is being set. All metal anchors should be securely built in as the work proceeds.

7. **Building of leads at jambs.**

Lay up leads in backing at jambs and fill in between window openings or between opening and corner.

8. **Setting lintel steel and completing the wall to underside of ceiling.**

Assist the ironworker in setting the beams or angles used for support of brick backing over openings and proceed with the laying up of brick wall between corner leads.

9. **Turning arches.**

Where arched head openings occur, the bricklayer will assist the carpenter in setting the wood centers. Lay up rowlock arches either 1, 2, or 3 courses high as required by the width of opening and as indicated in the drawings. Start laying arches from both jambs and build toward the center. Care should be taken in filling in the spaces between all rowlock brick and wedging the last brick tightly in place to securely key the arch.

10. **Bedding of bearing plates for structural beams.**

When main beams are to be bedded in the wall the three or four courses of brick immediately underneath the beam must be alternately bonded with headers and stretchers. Beds will be provided for the ironworker in bedding on wall the steel bearing plates for structural beams. For timber floor construction, cast iron sockets that provide the bearing for timber beams will be similarly bedded in mortar on the brickwork.

11. **Building in ties for furring.**

Galvanized sheet metal or galvanized wire ties should be built into the bed joints when required for attachment of furring in same manner as provided for in a previous job operation.

QUESTIONS

1. What is the customary thickness of load-bearing wall?

2. What is the rule with regard to the number of bond stone to use in load-bearing wall?

3. When stone faces are several feet in height how are anchors placed?

Job Instruction Sheet

Block–BL–1.—Semifinished work.

Job specification I7.—Turning simple arches with common brick on 8-inch wall with temporary centers.

Type job *a*.—Turning a rowlock relieving arch over window or door openings.

PRELIMINARY

The wood centering for relieving arches is made by the carpenter. The bricklayer assists the carpenter in setting it in place. As indicated in figure 29 the end of the centering on the left hand side rests on the jamb of the opening and the centering on the right hand side is supported by timber. Small wood wedges are usually placed under the bearings of these centers so that the centers and framework may be easily removed.

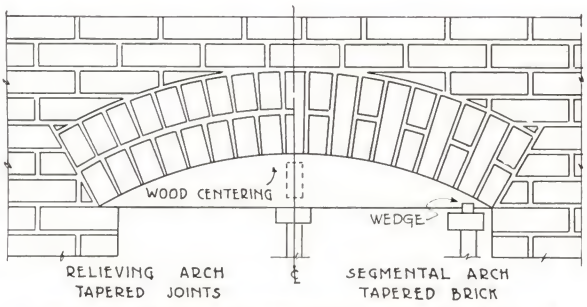

Figure 29.—Relieving and segmental arches laid up in the backing of a solid brick wall.

Most relieving arches are used in walls of residences, apartments, and industrial buildings.

1. Setting permanent centers for relieving arch.

a. Place the centers on the jambs even with the face of the inside. These centers should be at least 2 inches longer than the opening to permit the ends to rest on the jambs.

2. Securing the angle of the skewback.

It is not necessary for the bricklayer to know the radius of the wood centering in order to cut the skewback brick at the proper angle. The length of the radius commonly used in laying out the centering for a segmental arch is equal to the span of the opening.

a. By use of bevel square: Set the blade of the bevel square against a brick which is temporarily placed in an upright position on the centering at the spring of the arch. Use the bevel thus obtained to mark off the slope of the brick. Reverse the bevel to mark off the slope of the brick on the opposite side.

3. **Laying up skewback.**

Lay up the cut skewbacks to the height of the arch.

This particular skewback is three courses high.

4. **Starting to lay the arch.**

a. Stretch line on second course of skewback across the face of the opening. Lay up four or five brick on each side of arch, working toward the center.

5. **Completing the first rowlock.**

a. Within a few courses of the center lay the brick dry to determine size of cross joint.

b. Lay up brick according to space arrangement.

6. **Starting the second rowlock.**

a. Stretch line so a good portion of the rowlock arch will be within the range of the line. In order to stretch the line for the second rowlock, it will be necessary to raise the leads higher than the skewbacks on each side.

b. To start the second rowlock. Repeat the operations carried out in laying up the first rowlock course.

7. **Completing the second rowlock.**

a. Use the same method in completing the second course as was used in completing the first rowlock. Figure 29 shows the second course of rowlock laid over first course.

8. **Cutting the creepers over the arch.**

a. Mark the brick carefully to fit the space over the arch in each course.

b. Cut the brick and check to see that they are of the proper size.

9. **Laying creepers.**

a. Lay up creepers on both sides of the arch.

b. Lay up two courses of stretchers over the arch.

CAUTIONS

1. Be sure to determine proper angle of skewback.
2. Keep rowlocks well behind line because arches will spread when weight is imposed on them.
3. The joints of top rowlock should not line up with joint of bottom rowlock.
4. The top rowlocks should line up with the radius of the arch.

QUESTIONS

1. *Where is this type of relieving arch generally used?*
2. *Why does a center rest upon the jambs?*
3. *Why are proper angles of skewbacks required?*
4. *Is a key required for this type of arch?*

Job Instruction Sheet

Block–BL–II.—Jobs calling for finished work.

Type-job specification 2A.—Laying up an 8-inch or 13-inch wall in common or American bond with or without openings and backed up with brick, tile or cinder block.

Type-job *c*.—Laying up the outside tier of a 13-inch wall using common bond and backing with 8-inch hollow tile.

Figure 30.—Method of starting the first stretcher course on headers in a face wall which is to be backed up by other material.

PRELIMINARY

Walls 13 inches in thickness may be backed up with hollow tile concrete blocks or cinder concrete blocks instead of brick. In this particular job an 8-inch hollow tile is used. These hollow tile vary in size and shape, depending on the type of construction. In any case 8-inch hollow tile either partition or wall-bearing have a number of cells which greatly reduce the weight of the finished wall. These hollow spaces serve as insulation. The inside face of hollow backing-up tile is scored for use as a plastering base.

Figure 31.—Learner laying out first course for a return corner.

1. Laying out the first course.

It is the custom to start any wall or corner with a header course. This is not always necessary but in this particular job we are to follow the usual practice. See figure 30.

a. Lay out a return corner of headers with two ¾-brick on the corner so as to break the bond. Figure 31 illustrates the method of laying out the headers for an outside corner.

b. Lay out a sufficient number of headers in the first course so the stretcher courses can be laid up to header height.

Figure 32.—The completion of the first "setting up" of the facing in a 13-inch return corner. The back of the outside tier is being parged.

2. Laying out stretchers.

a. Lay up five courses of stretchers to an 11-inch gage to header height. Figure 30 and figure 32 illustrate the method of starting and finishing the laying up of stretchers to header height.

3. Parging.

Parge the back of the face tier with mortar to help in waterproofing the wall. Figure 32 shows the method of parging the back of a face tier.

Figure 33.—Backing tile laid to header height on a 13-inch return corner.

4. Backing up with hollow tile.

Lay up hollow tile to header height. There are several types of backing up hollow tile, all of which are shaped to receive headers so as to tie in the face of the wall with backing. Figure 33 illustrates the tile laid up on one side of the corner to receive the header.

5. Starting the second "setting up."

Lay up stretchers to header height. In completing the first "setting up" three or more stretchers were used. This will indicate that you have sufficient space for the next "setting up". Figure 34 illustrates laying of first stretcher course of the second "setting up".

Figure 34.—Beginning the second setting on a 13-inch hollow tile backed wall.

6. Ranging the "tailings."

a. Determine if the "tailings" of the corner are in line by means of a straight edge. If the tailings are out of line the finished wall surface will have a wavy appearance. Figure 35 illustrates method of "ranging" a tailing.

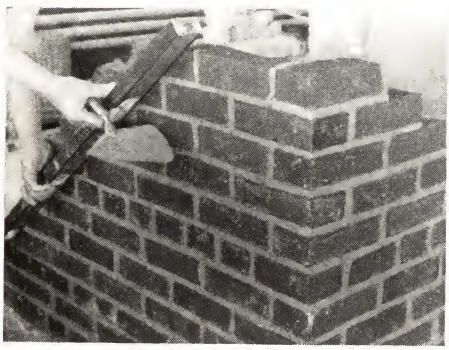

Figure 35.—Truing the "tailing" of the outside tier of a 13-inch hollow-tile backed wall.

7. Parging and laying up backing tile on second setting up.

The procedure followed in laying up this part of the wall is practically the same as carried out in laying up first "setting up".

Care must be taken to have top of backing tile come out even and level with the header course. Figure 36 and figure 37 illustrate the two steps just described and figure 38 shows the completed corner of a 13-inch wall.

Figure 36.—Laying backing tile on header courses of a 13-inch tile-backed corner.

Figure 37.—Two settings of hollow tile backing in a 13-inch brick-faced corner.

CAUTIONS

1. Be sure that the ¾-length brick at corners are uniform in size.
2. Keep tailings clean of mortar.
3. Be sure to keep the course in gage.
4. Be sure to completely fill cross joint in last brick on course.

QUESTIONS

1. Why is it advisable to use only a flush joint on a rough-textured brick?

2. How many stretchers are required in the laying out to complete two settings of a return corner?

Job Instruction Sheet.

Block–BL–II.—Jobs calling for finished work.

Job Specification 13.—Laying up straight surface with glazed brick, using running bond.

Type-job *b*.—Inside veneered straight wall with base and cap courses.

PRELIMINARY

Brick shapes with glazed surfaces are used extensively for structural purposes and for veneering existing masonry walls. This

Figure 38.—Completed corner of a 13-inch brick-faced return corner which has been backed up with hollow tile.

material is made in a variety of sizes and shapes to conform with structural needs. The sizes vary from 1¾ inches to 3⅞ inches in thickness. The height of the units are from 2¼ inches to 8 inches and length from 8 inches to 16¼ inches. Among the shapes made for inside and outside use are returns, reveals, coves, caps, bases, bullnoses, and quoins. Special shapes are made to meet structural conditions, such as those found in the lining of swimming pools, operating rooms, showers, and similar features. Figure 39 illustrates a few of the standard and special shapes of glazed brick and figure 40 shows special shapes used in swimming pool construction.

Figure 39.—Standard and special shapes of glazed brick.

The brick are glazed to a mat, satin, or glossy surface and are made in a variety of colors. They are laid up similar to unglazed brick, and with standard bricklayer's tools except that a power-driven grinding wheel is used to score the glazed surface.

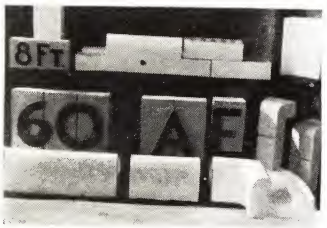

Figure 40.—Special shapes of glazed brick used in swimming pool construction.

This particular job calls for lining a masonry wall which has a window opening. Figure 41 indicates that a brick of 1¾-inch thickness is used. Special shapes are needed for the base, cap, and window trim.

1. **Reading setting drawing.**

Secure the floor level from the drawings. This is usually obtained from adjacent existing permanent floor levels.

2. **Placing screeds for cove.**

Screeds are placed on the floor at proper distance from existing walls or other trim features around window and door openings and at a height which corresponds to the level of permanent adjacent floors.

3. Laying cove base.

The pieces for a particular job are all marked by numbers and letters placed on the back. Those of the same shape and size have the same number or symbol. The setting drawing shows these numbers or symbols and it is necessary for the bricklayer to sort out the various shapes and sizes.

a. Start with a coped-cove member laid against a cove stretcher and lay from left to right.

b. Continue to lay out one side of wall, being careful to maintain uniform joints as specified on the drawing.

4. Finishing cove base.

Continue to lay up cove, working from left to right and using coped members at corners. Since the first stretcher is laid in a temporary position, it will be necessary to relay stretcher to complete the cove base.

5. Laying up stretcher courses.

a. Start at a corner and work from left to right, laying a course at a time.

b. Level and plumb each course carefully.

c. Lay up to sill height or other opening, keeping uniform mortar joint.

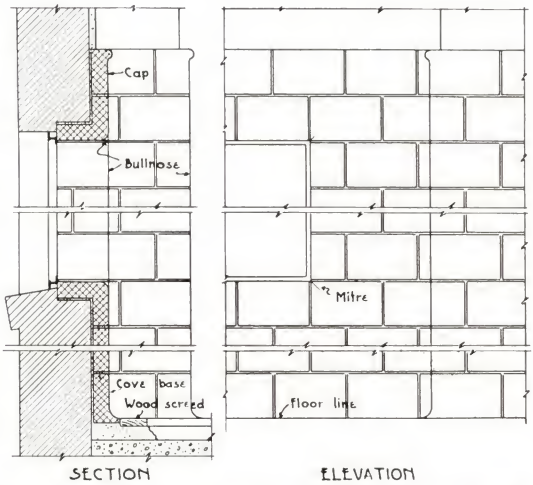

Figure 41.—Cross section and elevation drawing showing the construction of glazed brick interior wall facing.

6. Laying trim around openings.

In this particular job, which is illustrated in figure 41, is a window opening, trimmed flush with the finished wall. It will be necessary to lay up sill and jambs, keeping courses level and plumb.

In laying up lintel it will be necessary to place a temporary center, properly braced, on which the lintel brick can be laid in place.

7. Laying up balance of wall to height of cap.

In this particular job the cap course is the next course above the window trim. In other jobs it will be necessary to lay up one or more courses to a designated height.

8. Anchoring veneering to wall.

Metal rustproof ties should be placed in alternate courses and spaced from 2 to 3 feet apart.

9. **Laying cap course.**

Start in corner with coped member and work from left to right in the same manner as you laid up base course.

10. **Jointing the courses.**

This type of material is usually laid with a close joint and finished with a concave joint. Use a concave jointer that does not stain the mortar. Figure 42 shows a partially laid up glazed brick wall and figure 43 a completed glazed brick job on auditorium stage.

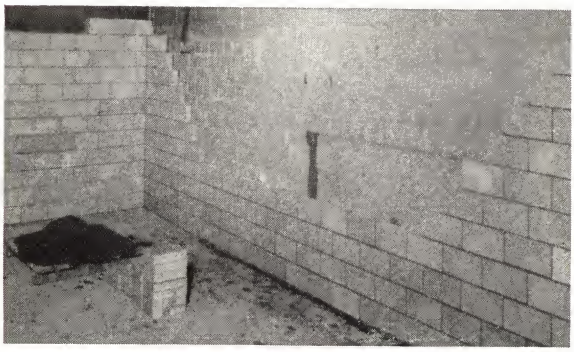

Figure 42.—Veneering basement wall with glazed brick.

11. **Cleaning the wall.**

Clean walls with a damp cloth.

CAUTIONS

1. Be sure to check walls to see that they are plumb and the corners square.

Glazed brick should be handled with care to avoid chipping the edges or marring the glazed surface.

2. Datum points must be maintained throughout so that joints will be uniform in width.

3. Do not use a brush in cleaning glazed brick walls as the brush is apt to scratch the joints. Walls laid up with glazed brick are easily cleaned with a damp cloth.

4. Jointing should be done uniformly with a rod and non-staining jointer tool.

5. The curved members of the cap course must be lined up.

Rembrandt Photo

Figure 43.—Auditorium stage in school building laid up of glazed brick. Associated architects, M. M. Steen in charge.

QUESTIONS

1. Why are screeds laid on floor for the base course?

2. Why is it necessary to carry the courses from left to right?

3. Why is a cloth instead of a brush used for cleaning the face of the wall?

Figure 44 is a perspective view of a glazed-brick shower.

Figure 45 is a plan and section drawing showing the construction of this shower. It will be noted that the receptacle is made of reinforced concrete and that the second course of glazed brick in the lining of the shower are grooved so as to make a watertight joint between the base and the walls.

Figure 46 shows the method of laying up and bonding the various courses in the wall.

The drawings illustrated in figures 44, 45, and 46 might be considered as setting drawings to be used by the bricklayer in laying up this glazed-brick shower.

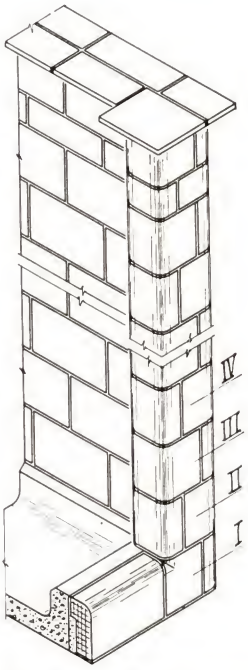

Figure 44.—Perspective view of a glazed-brick shower.

TECHNICAL INSTRUCTION

A job technical sheet similar in outline to the job instruction sheet can be used by the instructor. There follows in this section a sample job technical sheet covering Type Job No. 1 under Block 3 of the analysis of the bricklayer's trade. The technical job instruction consists of information suggested in the job analysis charts under the classification headings, "Recognition of stock," "Care of tools and equipment," and "Science." This information is so closely related to the job instruction that it is almost impossible to give the job instruction without including much of the technical information.

In presenting the technical instruction, the instructor should demonstrate, when possible, and provide ample opportunity for the apprentice to apply the new ideas brought out in the demonstration. For example, if a job involves an understanding of linear measurement as applied to wall surfaces and the device used for measuring is a story pole, the instructor should first explain the use of a story pole and the application of the brick-and-mortar joint as a unit of measurement. The apprentice should then have an opportunity to apply this information by measuring sill heights and window openings using a marked-off story pole.

The sample technical sheet which gives in detail the technical information related to a particular job is included merely to show the instructor how he can prepare other lessons. The instructor will find considerable material to assist him in outlining these job and technical

sheets from a list of references given in the appendixes. The source material which will be of most value is that obtained from bulletins and catalogs issued by the various manufacturers of building materials and the associations representing groups of manufacturers.

The following outline has been used in writing this job technical sheet:

1. Heading, giving key to instruction sheet and type job on chart.
2. Discussion of other jobs in this group.
3. The technical information such as found under the following headings on the analysis charts:
   - Recognition of stock.
   - Care of tools and equipment.
   - Science.
4. Questions.
5. References to general texts.

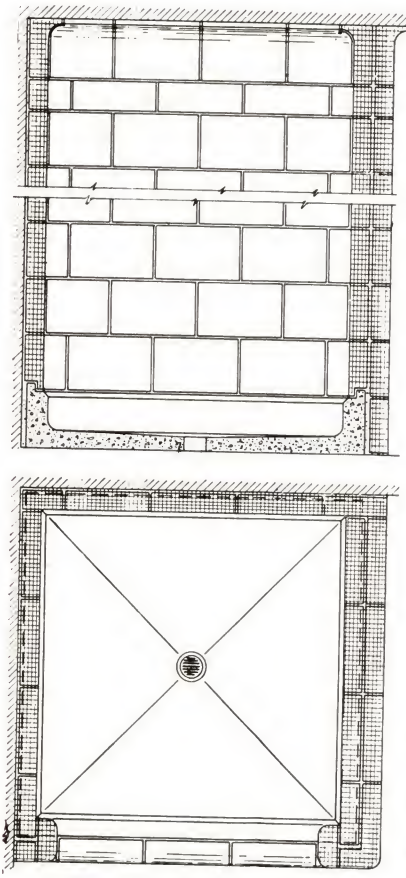

Figure 45.—Plan and section view of a glazed-brick shower.

The upper section shows a precast concrete receptacle used as the base of this shower.

Job Technical Sheet (Suggestive Sample)

Block BL–III.—Setting architectural terra-cotta and cut-stone trim.

Type-job specification 1.—Setting a one-piece cut-stone slip sill.

Type-job *a*.—Setting a one-piece cut-stone window sill.

PRELIMINARY

Cut stone and architectural terra cotta are materials used for both structural and ornamental trim of exteriors of buildings in combination with brick. These materials are used for grade or base courses, sill, lintels, quoins, and belt courses in outside brick walls. You are setting a cut-stone sill of the simplest type called a slip sill. This type of sill does not extend into the brickwork of the jambs but is cut to fit between the jambs. This type of stone sill when set into the wall does not support any weight except the window frame.

1. **Kind of sills**

The slip sill consists of a slab of soft stone, 3, 4, or 5 inches thick, of

the required width and length set on the wall with a slight outward pitch. The outer face of a slip sill may project from one to two inches beyond the face of the wall so that the water will be carried out over the face. Slip sills are used to protect the brickwork underneath windows. Stone and terra-cotta copings are used for similar purposes.

2. **Joints**

The weak spot in the sill is the end joint where it abuts the brickwork of the window jamb. Unless the end joints are carefully slushed

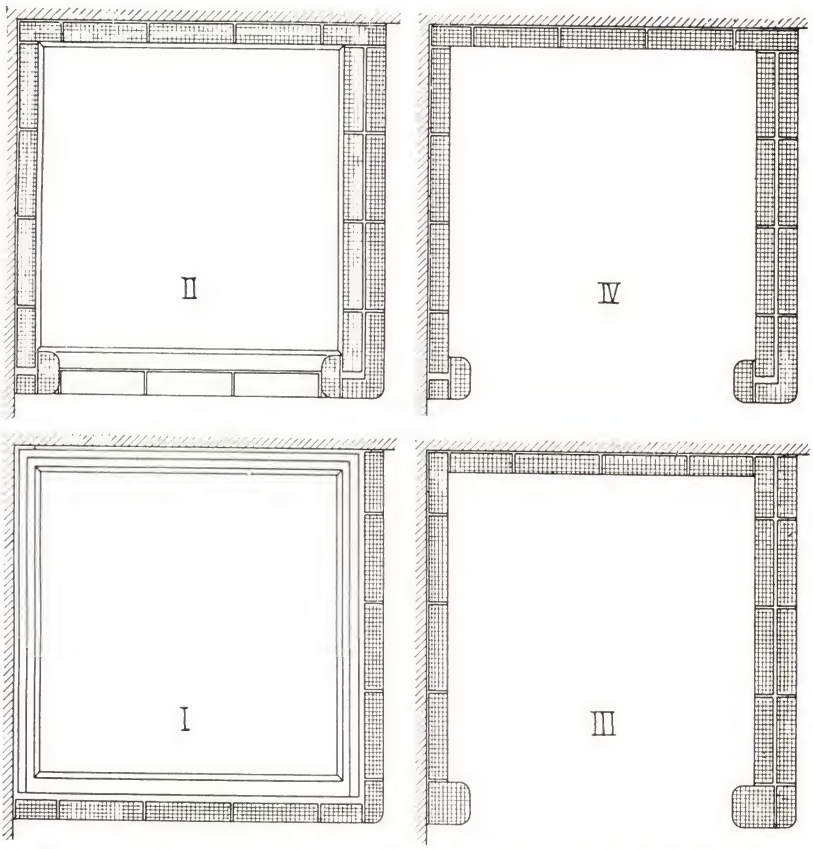

Figure 46.—The method of laying up glazed brick in the first four courses of a glazed-brick shower.

full of mortar, water may work through these joints to the brickwork below.

A drip is cut on the under side of a slip sill which consists of a groove on the projecting part of the sill, usually ½ inch to ¾ inch wide and about ½ inch deep.

Slip sills are sometimes set without an overhang, the face of the stone being set flush with the face of the brick wall, but this is unusual.

Where slip sills are set flush in this manner it is for an architectural effect.

3. Care of cut stone

All cut stone should be carefully cleaned with water and a brush before being placed in the wall. The sill should also be protected with paper and a board frame so that it will not be covered with mortar or accidentally broken by falling materials.

QUESTIONS

1. How does a lug sill differ from a slip sill?

2. When should stone sills be pointed up in the center and why is this done?

Reference.—In connection with this technical sheet you are referred to the following sections and paragraphs in the text entitled "General vocational information":

G. V. III. Materials of the trade.
3. Cut stone.
a. A kind of stone commonly used with brickwork.
G. V. IV. Details of construction.
3. Wall construction.
d. Combination of other materials.

Another type of job technical sheet describing load-bearing walls faced with cut stone or terra cotta is included in this section. The line drawings which accompany this job technical sheet show the method of construction of three types of walls. Figure 47 shows an enclosure wall with the stone facing resting on shelf angles; figure 49 an enclosure wall in which the bond stone rests on the floor slabs; and figure 50 an enclosure wall having the window and spandrel projected from the steel framework.

Job Technical Sheet

Block–BL–1.—Semifinished work.

Job specification 19.—Backing up stone facing of enclosure walls with brick.

Type-jobs *a*, *b*, and *c*.—Technical information relating to the backing up of stone facings with brick or hollow tile on load-bearing and enclosure walls.

PRELIMINARY

In enclosure wall construction, a considerable part of the exterior surface of the walls is taken up with window openings and piers. These piers between the windows enclose the wall-column and pipe ducts that are so frequently included in this type of construction. The backing up of cut stone facings enclosing these walls consists not

only of laying up brick backing wall under and around window openings, but also building in the structural steel columns when the frame is of steel construction.

When the frame is of reinforced concrete or the wall columns of structural steel encased with a fireproofing of concrete, it is necessary to back up stonework between the piers, since the cut-stone facings are generally set directly against the fireproofed columns.

When the steel columns are to be built in with the brick backing, which is the customary procedure, the bricklayer fills in solidly the two upright channel spaces formed by the flanges of the usual H column section.

After the channel spaces have been filled to a height of about two feet, brick is laid up around the column. Since the brick casings of columns are bonded into the brick backing of the wall between columns, a lead is laid up extending the two or three brick out from the column on each side. The backing wall is laid up between the leads and the sequence of operations repeated. The minimum thickness for backing a 4-inch cut-stone facings of enclosure walls is 8 inches, thus making the thickness of enclosure walls 12 inches. This width of wall permits both the inside backing and the 4-inch wall around columns to be bonded together.

Stone facings of enclosure walls either 4 inches or more in thickness will have part of the stone facing 4 inches thicker to form a bond stone or bond courses. In skeleton frame building construction, there is usually one such bond course to each story height. Sometimes, the bond stones are scattered throughout the wall so that the bonding of the face to the backing will equal 20 percent or more of face area of wall. Where these bond stones or bond courses occur the brick backing will be only one tier or 4 inches in thickness.

Brickwork of backing should be carefully cut to fit the bond stone at the points where they extend into the wall. If the bond stone occur in a regular course it is the practice to have the brick backing built up level with the facing so that the bond stone may be set on a mortar bed spread for the entire depth of the bond stone.

In laying out and building up a brick backing, it is advisable to determine the thickness of mortar bed joints so that the brick backing will work out level with top bed of stone courses, thus avoiding as far as possible the cutting of brick. This will simplify the cutting of brick that may be required in order to fit around steel anchors for cut-stone facings which must be solidly built into the brick backing. Since the anchors used for holding the cut-stone facing to brick backing are placed at the top edge of stone it will save considerable cutting of brick if the backing is level with the bond stone.

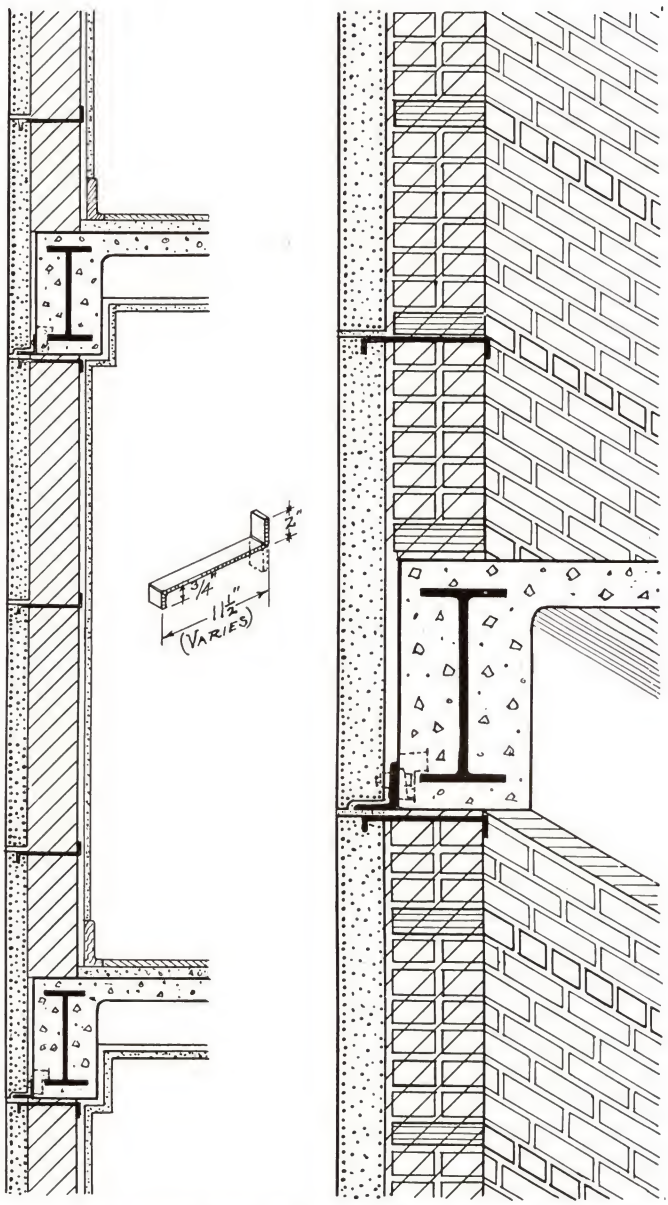

Figure 47.—Stone facings supported by shelf angles anchored to backing and to structural frame.

Often with enclosure wall construction, it will be necessary to build in horizontal chases under windows in order to provide space for the concealed installation of steam or hot water heating pipes that connect the radiators. The main supply risers are generally encased with hollow tile or metal lath furring before the walls are plastered.

In load-bearing wall construction it is sometimes found necessary to strengthen the walls at certain points. This is done by building walls of greater thickness so as to form a pier upon which the main girders supporting floor construction are to rest.

It is common practice to lay up pipe and conduit chases in the backing walls at various points where it is necessary to provide for conduit lines and other service equipment within the thickness of the wall. Figure 48 shows how these chases are provided in the brick backing. Where chases of this kind must be provided, particular attention should be given to the bonding of brick around these openings since they generally occur adjacent to the pier sections of walls that support the floor girders.

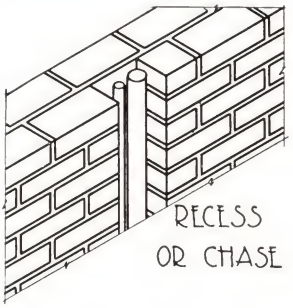

Figure 48.—The method of building in chases for pipes or conduits in the backing of a brick wall.

Metal window frames of any type having anchors attached must have these anchors built solidly into the wall as the work progresses. This should be done either by cutting the brick or by spacing the brick courses so that the anchors are placed in the joints. The bricklayer, therefore, must give some thought to spacing his mortar joints.

The interior brick backing of walls does not show in the finished building so a uniform thickness of mortar joint is not absolutely essential in this type of work, and the brick bed joints at some points may be held down to ⅜ inch or increased over the customary ½-inch thickness. The purpose of this increase or decrease of mortar bed joints is to make it possible to lay up the backing level at the bed joint where bond stones are set. Particular attention should be given to filling in with mortar all back joints between stone facing and brick backing. Where a different mortar is used for setting stone than for laying up brick backing, the specifications will usually require that the back of the stone be parged with stone-setting mortar just prior to the building up of the backing. This is done to interpose a layer of nonstaining mortar between the stone facing and brick backing.

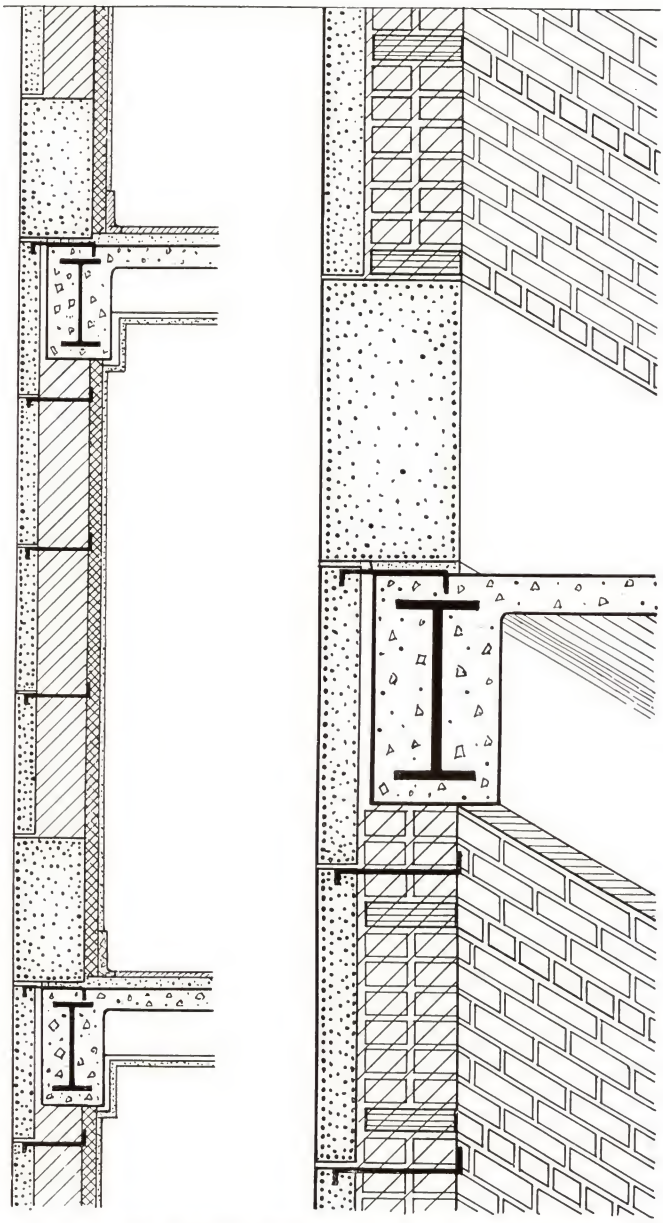

Figure 49.—Stone facings with bond stones bonded and anchored to backing and to frame.

Probably the best method of building up the brick backing of a load-bearing or an enclosure wall is to push the brick with buttered end into a previously spread bed of mortar. Any spaces between the backing and the wall facing should be filled solidly with mortar thus leaving no pockets for the accumulation of moisture.

Architects' specifications and city building codes or ordinances may require that in backing up cut-stone facings, not more than two courses of stone facing be set in advance of the laying up of brick backing. If the stone facing is 8 inches or more in thickness, which gives a sufficient bed area in proportion to the height of course to form a wall that is naturally stable, several courses of stone may be set before the backing is carried up. Even in backing up walls with thicker facings the bonding stone should be set after the backing wall has been laid up level with the face course.

The best practice to follow in enclosure-wall and other types of light wall construction is to so organize the work that the laying up of brick backing from interior scaffold will proceed along with or just a little behind the setting of stone facing by the stone masons working from an outside scaffold. If high ashlar courses of any kind are used, the brick backing should be laid up as soon as each stone course is set and before the next course of stone is bedded on the one below.

In backing up cut stone with brick or hollow tile, a mortar mixture which is sufficiently rich to provide the required strength and adhesive or bonding qualities should be used so there will be no tendency for the mortar to shrink or to slump down in the process of setting and hardening.

It is important that the brick backing laid up on the underside of spandrel beams or girders be wedged solidly to prevent the brick backing from settling and causing a crack between the top of the backing and the underside of the sprandel beam.

QUESTIONS

1. What is the main difference between enclosure wall and bearing-wall construction?

2. How are enclosure walls generally supported?

3. What is the customary thickness of enclosure walls?

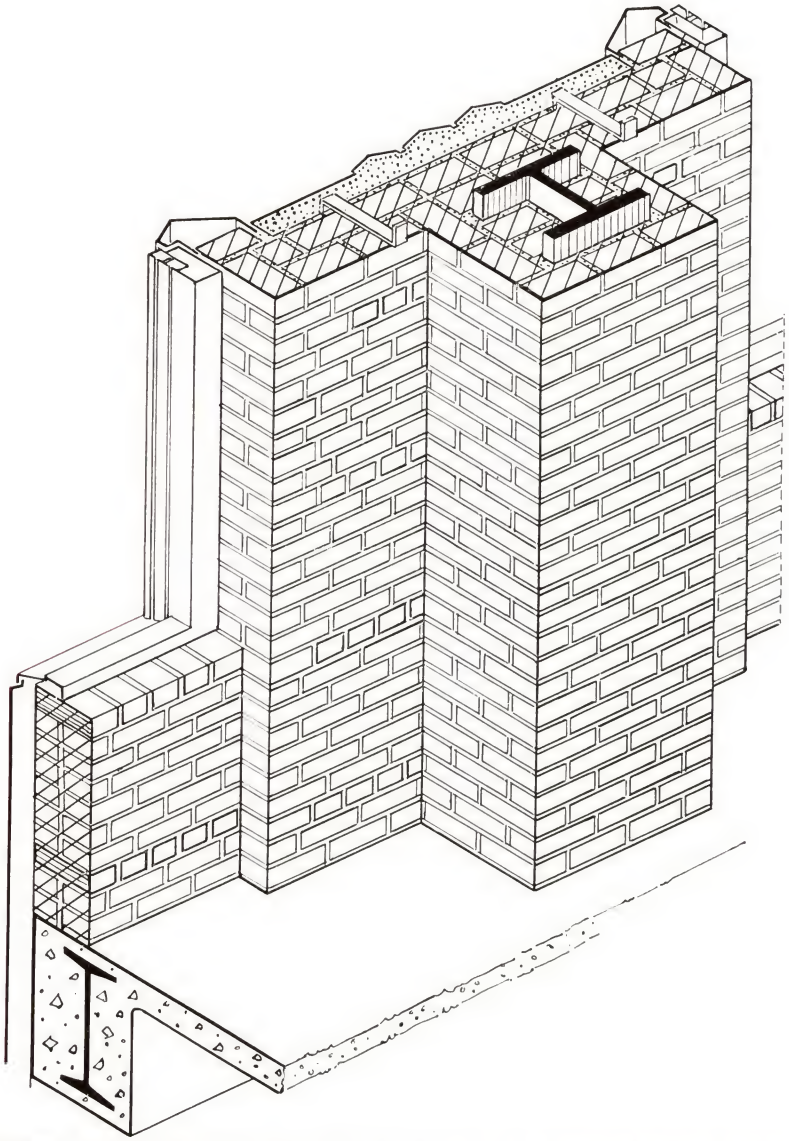

Figure 50.—Stone facings in which windows and metal or other types of spandrel panels are projected flush with face of wall.

GENERAL VOCATIONAL INFORMATION SUBJECTS

When possible, job and technical instruction should be given on the job. General vocational information which is not directly related to the job practice cannot be given on the job, but should be given in an organized part-time or evening extension classes.

Subjects which should be included in general vocational courses divide themselves into two general groups—those of a technical nature such as drawing, applied art, science, and mathematics; and those which might be termed informational subjects, such as the history of the trade, industrial economics, and materials of the trade. These subjects should not be given with the idea of merely imparting information to the apprentice, but in connection with their application to actual problems met with in the trade.

It is not the purpose in suggesting outlines which may be used in presenting instruction in general vocational information subjects, to develop material to be used by the instructor in giving assignments which the learner can read and later discuss in class. The best method of giving instruction in general vocational information subjects and the one recommended is to present it in connection with specific instances of trade practice brought out from time to time by apprentices. These instances or cases should be based upon the experiences of the apprentice as they come to him in the practice of his trade. Under this plan, the material developed from the outline of general vocational information subjects will be used more as reference than as text material. The following suggestions are presented for the guidance of those who desire ideas for developing instruction in drawing for bricklaying apprentices.

V. Drawing.

The principal items stressed in drawing courses for bricklayers are: (*a*) The reading of drawings, and (*b*) the making of sketches. Two methods are commonly used to instruct apprentices in reading drawings. Under the first method the apprentice learns to read drawings by studying them and interpreting them to the instructor who, in turn, corrects any misunderstanding of the drawing the apprentice reveals in his explanation. Under the second method the apprentice learns to read the drawing by using it as a sheet of directions, and laying out brick or other masonry materials in the positions indicated in the drawing. In practice work the materials are laid up "dry"; that is, a space is left between the brick to represent the mortar, bed, and end joints.

Although at first it may seem to the instructor to be impossible to get all the materials needed to carry out this method of instruction, maximum learning results are possible only when this method of teaching is followed.

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The objective of a course in the reading of drawings is to permit the apprentice to acquire the ability to assemble materials the bricklayer uses on the jobs as indicated by a setting plan or detailed drawings.

If the drawings call for an assembly of cut stone or terra cotta in the form of a sill or lintel, or molded brick to be laid up as the entrance feature of a brick building, these pieces should be laid out flat on the floor of their respective positions in order to avoid the necessity of anchoring the individual pieces to the wall. If the drawing calls for an assembly involving a number of repeats in the materials used, the apprentice need assemble only enough of the different sections to get an idea of how the materials are to be laid up. If necessary the instructor may formulate questions which can be asked the apprentice to test his knowledge of the way in which the job he has started should be completed in order to comply with the drawings.

Figure 51.—Curved stairway at main entrance of Chapel, Divinity School Group, Yale University, New Haven, Conn.

Shows use of brick in combination with other materials—stone and ornamental wrought iron.

Below is a suggested list of jobs that an apprentice might be asked to perform with the help of drawings furnished by architects or manufacturers. These are—

Laying up or setting—

1. A portion of a brick floor.
2. An outside face-brick chimney.
3. A cut-stone water-table course.
4. Terra-cotta or cut-stone quoins in a brick field.
5. A molded-brick arch.
6. A terra-cotta sill course.
7. A 3-piece terra-cotta sill.
8. A terra-cotta window or door frame.
9. A cut-stone mullioned window frame.
10. Terra-cotta columns.
11. A 2-piece cornice.
12. Terra-cotta or cut-stone medallion in a brick field.
13. Repeated brick pattern in a cornice.
14. A molded-brick chimney.

Manufacturers and jobbers of brick and other clay products have worked out a number of devices that may be used by the instructor

in connection with a course in reading drawings or making sketches. For instance, where brick are to be laid up dry a lath colored to imitate a mortar joint and cut to definite lengths may be used to show proper spacing of the joints. Small scale-sized models of brick and structural tile may be secured and laid up dry to illustrate various pattern bonds from which sketches can be made.

Making Sketches.—The objective of a course in sketching is to permit the apprentice to acquire the ability to make detailed free-hand sketches from drawings and specifications. (During second or third year; estimated time, 40 hours.)

Figure 52.—An example of patterned brickwork in gable wall over the entrance to Cranbrook School grounds, Bloomfield Hills, Mich.

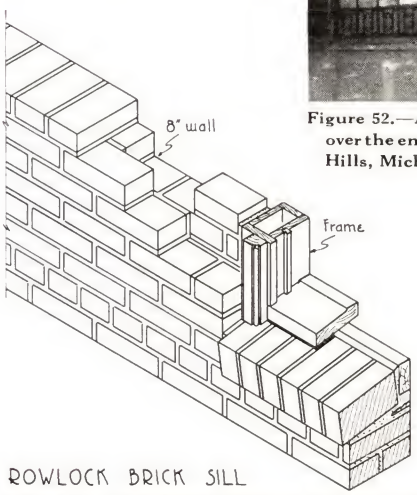


Figure 53.—Perspective sketch of rowlock brick sill in an 8-inch brick wall.

In outlining a course of instruction in sketching the problems should be set up in the form of detailed specifications and these specification problems, in turn, arranged in progressive order. Pencil and paper are the only materials necessary in the beginning stages of a course in sketching. The sketches the beginner is required to make are similar to those a practical bricklayer would make in illustrating the method of laying up a part of the job. A drawing course for bricklaying apprentices is not intended

as a course of instruction to train them to become draftsmen. Sketches of actual jobs which may be made by apprentices include:

1. Two-dimension sketches representing surfaces in elevation of—
   - *a*. A section of a brick wall in which common bond is used.
   - *b*. The corner of a building showing a corner lead laid up in common bond.
   - *c*. A portion of a wall laid up in common bond, with a header course.
   - *d*. A wall between a corner and a window opening, 4 feet apart, wall being laid up in running bond, and headers in every sixth course.
   - *e*. Flemish bond in an 8-inch wall.
   - *f*. The corner of an 8-inch wall in which Flemish bond is used.
   - *g*. A wall laid up with a soldier base course in which common bond is used and showing corner construction.
   - *h*. A wall with window opening having a soldier base course and a rowlock window sill.
   - *i*. A window opening showing the rowlock sill and a soldier lintel.
2. Two-dimension sketches representing surfaces in plan.
3. Two-dimension sketches representing vertical and horizontal sections.
4. Simple sketches in perspective.

Illustrating assignments.—To illustrate how a lesson might be presented, two suggestive assignments and the directions the apprentice should follow in making simple drawings are here presented.

1. A sketch of a section of a brick wall in common bond.

The simplest drawing that can be made is one showing the outline of an object in two dimensions; that is, representing on a flat surface, such as a sheet of paper, the length and height of an object in elevation.

Method to be followed: With a section of a wall as a model, the apprentice should make a sketch showing the bed and cross joints and the bricks in their positions in the section, observing the following directions:

- *a*. Look at the section of the wall and find out how many courses there are in the section.
- *b*. Draw parallel lines representing the bed courses equal distances apart.
- *c*. After the bed courses are laid out, mark off cross joints on lower course.

d. Place the cross joints as they appear to you on the next course above.

e. Erase the lines which run beyond the end of the course and see if the sketch you have made corresponds in height, length, and number of cross joints to the object from which the sketch has been made.

Checking.—If the apprentice, after checking over his drawing, feels that it is a fair representation of the real object he should ascertain from the instructor whether the drawing meets with his approval:

2. A sketch of a wall between a corner and a window opening, 4 feet apart, wall being laid up in running bond, and headers placed at every sixth course (without an actual wall to look at).

In making this sketch, it is necessary to find out how many brick are needed for the given distance. The distance between the window and corner is four feet. In measuring brick laid up in a wall it should be kept in mind that a brick and a mortar joint equals approximately 8½ inches. Divide the total distance by this figure to determine the number of brick that will go into this space. It may be necessary to use a half brick or a shorter piece to vary the width of the cross joints. Figure 53 shows a jamb and sill of a window frame in place on an 8-inch wall.

a. Proceed as in the previous sketch in laying out the courses.

b. Space off the number of brick that are required in the first course and mark the cross joints.

c. Proceed with next course, using cut brick where necessary.

Check up the drawing to make sure the spaces have been properly proportioned. These spaces should represent closely the wall you are drawing. By this time you should be able to make a fairly accurate sketch.

To the instructor.—It is suggested that in connection with the first drawing lesson the wall or parts of the wall to be sketched be laid up with actual brick and used as a model for making the sketch. Since there is no third dimension, these walls can be four inches in thickness, and thin strips of wood may be used instead of mortar to represent the bed and cross joints.

It is suggested that, in addition to the wall model, the apprentice use parts of architectural drawings showing sections of the building, such as the corner of a house, a window or door opening, or a course, in making his sketch.

Small drawing boards might be used to fasten the paper to so the learner may have a smooth surface on which to work. Sketches should be made entirely free-hand without the use of a ruler. It is suggested that a bricklayer's rule be used in checking up dimensions of the finished drawing.

III. Materials of the Trade.

1. Brick.

a. Kinds, burned and composition.

Preliminary.

The term "brick" is used in the construction industry to designate burned clay or shale units approximately $2\frac{1}{4} \times 3\frac{3}{4} \times 8$ inches in size. These dimensions may vary from a plus or minus $\frac{1}{8}$ inch in depth and width to $\frac{1}{4}$ inch in length in the several types of brick commonly used in building and engineering projects.

Figure 54.—A clay pit from which the clay is dug by a steam shovel and loaded into dump cars on narrow gage railway for delivery to brick plant.

Burned brick are classified as common, face, glazed or enameled, and fire and paving brick. Fire and paving brick are slightly larger in size than common or face brick.

Composition brick units, such as sand lime brick, or concrete cinder brick or block are used in conjunction with fired brick but should not be confused with brick produced by the burning process.

Materials used in producing brick.

The raw materials in the form of clays or shales from which burned brick are made are found in all parts of the country. Clays, including fire clay, are produced by the weathering of rocks. Shales are produced in practically the same way and from the same material, but differ from clays in that the shale has been compressed and, in some cases heated, producing a material that is much more dense than clay, and consequently, more difficult to remove from the bank or pit.

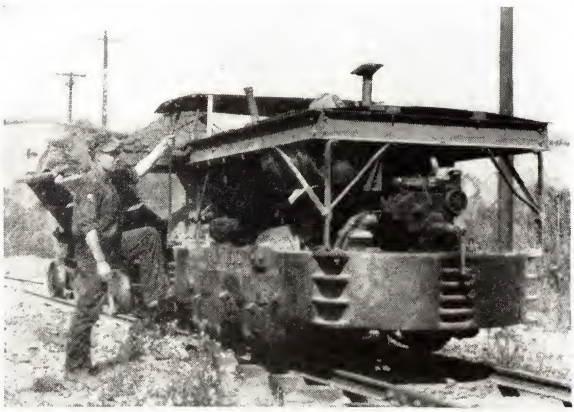


Figure 55.—Gasoline and electrically-propelled switch engines are used at brick plants for hauling the dump cars of clay or shale from the pit to the clay storage shed or bins.

The chemical composition of clay or shale and the method of firing them give the colors and texture to brick. The colors vary from a light cream to very dark red, with red, buff, and cream colors predominating.

Process of manufacturing.

Clay or shale is dug or quarried and in some cases allowed to weather in the open for a period of time. The purpose of weathering is to allow the material to break down naturally into a workable mass.

Figure 54 shows the method of removing the clay from a clay bank and loading it into cars to be transported to the brick plant. Figure 55 illustrates one type of equipment used to transfer the clay from the pit to the storage bins. Brick plants are usually located near the source of raw material. However, in some instances clay or shale is transported several miles by truck or rail.

Figure 56.—Removing clay from storage bins.

Clay or shale is dumped into the storage bins at the brick plant and conveyed to the grinders on an endless belt.

These raw materials must be dug or quarried and delivered to the brick plant without interruption, because brick manufacturing is a continuous process. Failure to deliver raw materials at the proper time may result in the shutting down of grinding and brick-burning equipment and the interruption of the schedule of production throughout the plant.

Figure 57.—A shale bank near a brick plant.

This bank is approximately 60 feet high and contains not only layers of shale and fire clay but veins of coal and slate. The coal is dug and used to fire the brick kilns; the slate is disposed of as waste and both the fire clay and the shale used in the manufacture of brick and other refractory materials.

Figure 57 shows a shale pit approximately 60 feet deep. The tracks used for transporting the material from pit to plant may be seen

in the foreground. The various strata of surface clay, shale, fire clay, coal, and slate may be clearly seen on the sides of the cut. The several veins of coal, measuring a few inches to a foot in depth are mined and the coal used for firing the brick kilns.

If the clay or shale delivered to the plant contains the proper ingredients for making brick it is a simple process to grind, mix, and mold the brick preparatory to firing. In most instances, however, the process is not so simple. It may be necessary to mix two or more kinds of shale, clay, or other ingredients in order to produce a mixture of the proper consistency.

Figure 58.—A crude home-made "pug" mill used to produce hand-made brick.

The clay is pugged to the proper consistency in the mixing box and then placed in molds which have previously been dipped in sand. The brickmaker is shown at the right filling a series of molds. The sand box is at the left.

There are several methods of molding brick. Among these are the soft-mud, stiff mud, and dry-press processes. Each process requires a slightly different molding equipment, and the shale or clay must be mixed to the proper consistency for molding. It must be ground and mixed and the proper amount of water added. When sand-molded or water-struck brick is made by hand or with the aid of a machine, the material should be plastic enough to be forced into the molds and stiff enough that the brick will retain their shape when removed from the molds. If the brick are to be made by extruding through dies, the material must contain less water and therefore will be less plastic. If the dry-press process is used, only enough water should be added to hold the ground material firmly together.

Figure 56 shows a clay storage bin equipped with endless belt for conveying the raw material from the bins to the grinders. The clay or shale, after it is ground, is mixed with water and other materials and thoroughly "pugged" until it is plastic.

Figure 58 shows a "pug" mill of a crude type in which the clay is mixed to the proper consistency by means of wood paddles attached to a sweep. This picture also illustrates the soft-mud process of

making sand-molded brick. The brickmaker may be seen at the right molding six brick at a time in a mold box made of wood. This mold has been dipped in the box of sand at the left and the sand particles adhering to the sides and bottom of the mold facilitate the removal of the pressed clay. Approximately 4,000 brick are produced a day at this home-made plant. This is relatively a small number compared to the 50,000 to 100,000 brick produced per day per machine in modern power-driven plants.

Figure 59.—Molding brick by extruding process.

The stiff mud is forced through the die which gives it the shape of a brick on edge.

Figure 59 shows the method of molding brick by extruding the stiff mud through a die. The size of the die determines whether the extruded brick are to be "end cut" or "side cut."

Figure 60 illustrates the machine used to end cut or side cut the brick as they are extruded through the dies, and figure 61 shows a group of men stacking molded and wire-cut brick on trucks. These trucks are rolled into the drying ovens as soon as they are loaded.

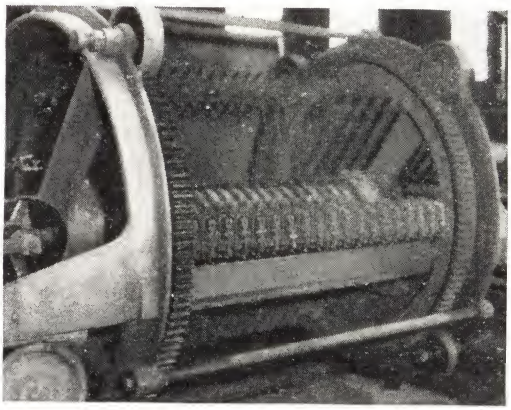


Figure 60.—Cutting molded brick to the proper length or height by means of wires.

Brick of special shapes, such as those used for corners, coves, and caps, are molded and finished by hand. Figure 62 shows the method of hand finishing special shapes which have previously been partially formed by a hydraulic press.

Drying.

An important part of the manufacturing of brick is the drying of the molded shapes. It is necessary to evaporate off a large amount of the water in the molded brick to assure greater strength in the preburned brick. The more thoroughly brick are dried, the easier it is

to stack them to the proper height in the kiln. The more water that is evaporated from the brick previous to burning the less fuel will be required to bring the brick to the fusing point in the kiln.

Molded brick are usually dried in ovens which are heated by the warm gases from the kilns. Figure 63 shows a drying oven from which trucks of dried brick are being removed. The molded brick remain in the dryer for two or more days, depending upon the amount of moisture that has to be evaporated.

Figure 61.— Stacking molded brick on trucks.

The molded brick have passed through the die of an extruding machine and are cut to the proper height.

In contrast to the oven method of drying is the open air method illustrated in figure 64. The molded brick are stacked in the open where the sun and wind cause the water in them to evaporate. Boards or waterproof paper are placed over each tier to carry off the rain or snow. It requires considerably more time to evaporate water from molded brick stacked in the open air than it does when brick are oven dried. The "pug" mill and kiln of the plant are shown in the background.

Kilns.

Several types of kilns are used for burning brick: (1) Round or beehive, (2) rectangular, (3) continuous or tunnel. These kilns are large ovens made of refractory brick or lined with refractory material. In most instances ducts or tunnels are constructed underneath the kilns to carry off the heated gases.

Figure 62.— Forming special shapes of glazed brick.

Brick of special shape, such as those used for corners, coves, caps, and returns, are formed by hand in wood or metal molds.

The type of kiln and the kind of brick to be fired determine the method of loading the kiln. Figure 65 illustrates the method of stacking brick in a round-shaped kiln. Spaces are left between the

Figure 63.—Removing molded brick from the drying ovens.

The purpose of drying brick before firing is to remove most of the surplus water in the "green brick" thus giving them more strength and making it possible to pile the brick higher in the kiln. Less fuel is required in firing if the surplus water in the brick is evaporated in the drying ovens. It takes from 2 to 3 days, depending upon the amount of moisture in the clay, for the brick to become dry enough for firing.

tiers so that the flames may circulate to all parts of the kiln. The bricks which are being stacked in this kiln are to be glazed, hence the face or ends are exposed to receive the proper heat. Figure 66 shows the inside of a rectangular-shaped kiln which has been fired and most of the burned brick removed. The openings in the floor lead to the ducts underneath the kiln. This kiln is constructed with permanent sides and top. Figure 67 shows an outside view of the kiln illustrated in figure 66. The permanent vertical walls of this kiln are held together by steel I-trusses with tie rods at the top. These rods not only hold the trusses in an upright position but also serve to support the thrust of the arched roof. This kiln is fired with coal, which is transported to the kiln on dump cars. Figures 7 and 69 show groups

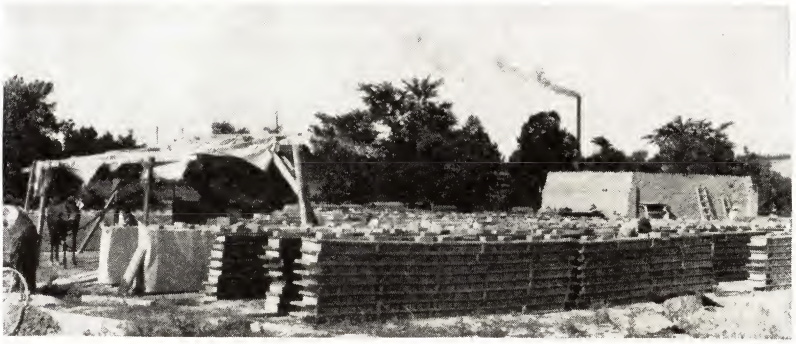


Figure 64.—Sand-molded brick stacked in piles for drying prior to being placed in the kiln for burning.

of round beehive type kilns, some of which are fired with coal and others with oil. It takes from 75 to 100 hours for the complete process of burning and cooling the brick. The kiln must be heated gradually to drive off the water or moisture remaining in the brick. This stage in the burning process is termed "water smoking." After the water has been completely evaporated the temperature is gradually raised until it reaches the vitrification point—the point at which the materials comprising the brick begin to fuse together. Different degrees of temperature are required for burning various mixtures and for producing certain colors or surface effects in the finished product.

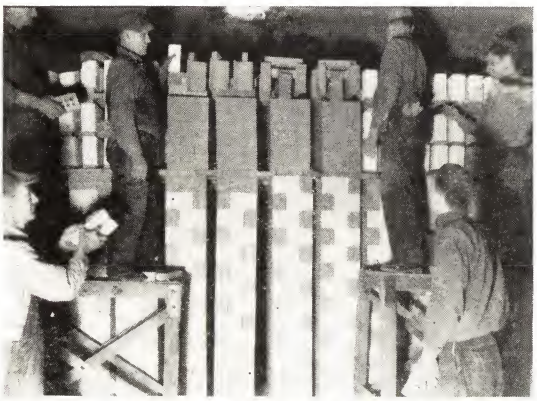


Figure 65.—Stacking glazed brick in a beehive type of kiln.

The faces of the stretchers and headers are arranged in the kiln so that they may be properly fired.

After it has been fired the heated mass is gradually cooled to avoid checking the surface of the brick. It takes practically as long to cool the kiln as it does to raise it to the proper burning heat.

Laboratory control.

The technical side of the brick industry is very important in that the materials used must be carefully analyzed and the temperature for firing determined. If the bricks are to be glazed, the mixture for the glazes must be very carefully prepared. Not only is the material which goes into the finished product thoroughly tested but small electric or gas-fired kilns are used to test the burning characteristics of the brick under controlled conditions. Figure 70 shows a ceramic laboratory in a large

Figure 66.—Unloading fired brick from rectangular type kiln.

The walls and crowned top of this kiln are of permanent construction. Holes in the floor lead to the tunnels underneath the kiln through which the hot gases are drawn by means of exhaust fans.

Figure 67.—Rectangular type of permanent brick kiln.

The walls and top of this kiln are constructed with permanent walls and arched top. The steel trusses on the sides and the tie rods at the top hold the walls in a vertical position, and support the arched top.

These kilns are fired with coal, which is transported to the kilns by means of dump cars. The sliding firing doors which can easily be opened or closed to regulate the draft are made of fire clay. The electric wires, seen at the top of the "I" beams are connected to thermal couples and lead to the central control room.

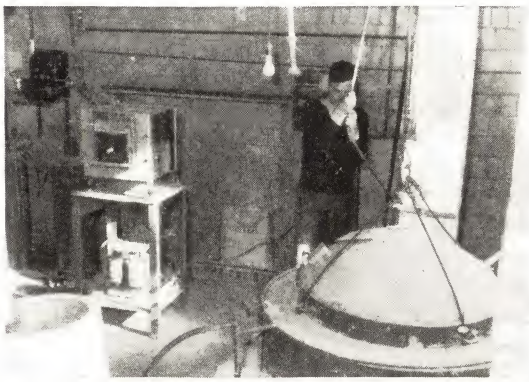


Figure 68.—Small test kilns are used in the laboratories of brick plants.

In order to determine the proper mixture of brick materials continual checking of the base material must be carried out in the laboratories. Small gas and electrically-fired kilns are used for this purpose.

Figure 69.—A group of beehive brick kilns.

The dried brick are delivered to the kilns from the drying ovens by an electrically-propelled switch engine. Transportation of material in a brick plant requires a considerable amount of equipment in the form of track, engines, cars, and trucks.

brick plant. Samples of various products which have been submitted to tests are on file in the laboratory. Figure 68 shows a small gas and electrically-heated kiln used for testing purposes.

It is very necessary to control the heat in the kiln so that loss from improper firing may be reduced to a minimum.

Figure 71 shows the inside of a kiln heat control room in which the kilns, as they are fired, are electrically connected to thermocouples located in the kilns. The degrees of temperature are recorded

Figure 70.—Testing laboratory in a brick plant.

The materials used in brick making are carefully analyzed to determine the proper mixtures of the body and glazes of the finished product.

by an instrument which indicates graphically any fluctuation in the temperature from hour to hour during the burning period. The one in charge of the control room is in constant touch with the kiln tenders by telephone. Figure 67 shows the electric wires attached to the uprights on the sides of rectangular kilns. Connections are made to these wires from heat registering devices inside the kilns.

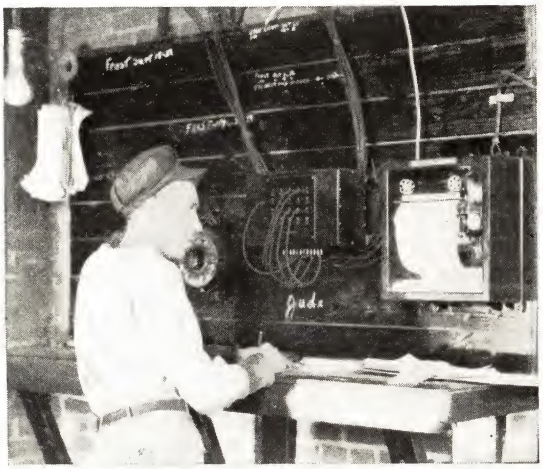


Figure 71.—Central kiln heat control room.

The kilns as they are fired are connected by an electric circuit to a control heat recording device. A continuous record of the temperature of the kilns through the entire firing and cooling period is thus secured. There are one or more electrically-connected thermo-couples in each kiln which transmit to the recording instrument the temperature of the kilns.

Cutting special shapes

When large quantities of cut-brick shapes are needed, as for arches over door or window openings, they can be cut or ground at the plant mechanically. This will save the bricklayer a considerable amount of time. Figure 72 shows a workman marking the shapes of a jack arch by means of patterns. These shapes are ground to the outline marking on them, shown in Figure 73, and packed in boxes and transported to the job.

Figure 74 shows boxes of ground brick for flat jack and segmental arches ready to be taken to the job. Each box contains brick for one or more arches.

Figure 72.—Laying out with patterns the individual brick for a flat jack arch.

Metal patterns are used to lay out the shape of brick previous to cutting.

III. Materials of the Trade.

6. Mortars.

a. **Properties.**

b. **Manufacturing of lime and Portland cement.**

c. **Kinds.**

Preliminary.

Mortar is a plastic mixture used to bind and hold together the various units in ma-

sonry construction. All types of mortars are composed of three essential elements: (1) The cementing medium-lime and cement; (2) the aggregate or filler, usually sand; and, (3) water, which is added to the mixture to give plasticity.

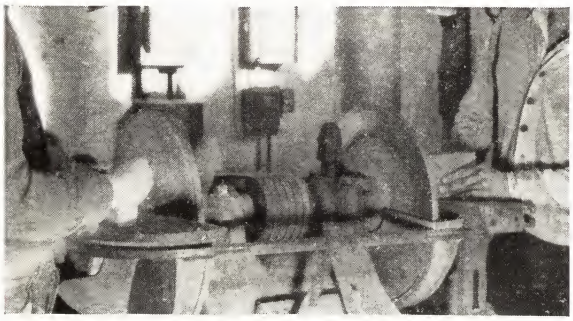


Figure 73.—Grinding brick to meet special construction requirements.

When it is necessary to cut a large number of brick to meet special structural conditions, such as jack arches over door or window openings, the brick are cut or ground to shape at the brick plant.

Mortar of the proper mixture and first quality masonry units are important factors in masonry construction. Workmanship, however, is much more important. A skilled craftsman who uses proper construction methods may lay up a good wall, even with ordinary brick and mortar of no great crushing strength, while an unskilled workman who uses the best brick and high strength mortar may lay up a poor wall.

Properties.

The binding or cementing material in any mortar mixture is cement or lime or a combination of these two materials. Lime is the oldest form of cementing material, and the walls of many of the ancient structures were laid up with plain lime mortar.

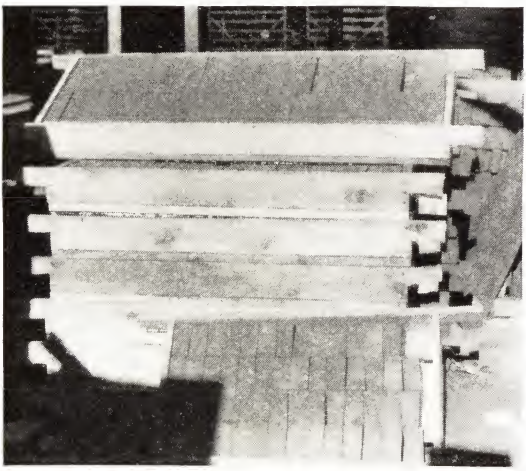


Figure 74. Jack arches cut ready to be laid in the wall.

These specially cut jack arches are packed in individual boxes in which they are transported to the job.

Hydraulic lime, which hardens under water, was discovered at an early date and used by the Romans in the construction of their roads and aqueducts. Known in the early days as "Roman cement," hydraulic lime is now referred to as natural cement.

Portland cement was discovered at a later date, and is universally used today where cement is employed as an ingredient in mortars. Several types of Portland cement are manufactured at present, each of which has its particular use as an ingredient in mortar mixtures.

Because of the scarcity of limestone deposits along the Atlantic seaboard, the lime used by the early settlers of this country was made from oyster shells. Recent excavations at Jamestown, Va., have unearthed some of the lime-burning kilns used by the colonists. Because of the fire hazard involved, lime could not be imported in the wooden vessels of the early days.

Manufacturing of lime and Portland cement.

Contrary to general belief, lime, like brick, was manufactured in this country at an early date. Lime was originally burned in crude kilns constructed in the side of banks near the sources of limestone deposits. Wood was used as a fuel in burning the limestone. Because of the unevenness in firing only a part of the burn could be used. The lime produced by this early method of burning was called lump lime or quick lime. Later coal was employed as a fuel and both the type of kiln and method of firing were greatly improved.

Coal, oil, or gas are used as fuels in modern kilns and the burning is so controlled that a uniform product is secured. Both limestone and marble are used for the production of lime. Because of the different chemical composition of limestone and marble, two types of lime are produced by burning. One is a high calcium lime, and the other contains a high percentage of magnesium. Generally speaking, mortar for building purposes is made with lime containing a high percentage of magnesium.

Lime is prepared for the market in lump, pulverized, and hydrated form. Hydrated lime is preslaked lime containing just enough water to break down the chemical structure of the lime and produce a dry powder, readily soluble in water. This method of preparation makes the lime easier to handle and more adaptable for certain forms of mortar. Regardless of the type of lime used it should be made into a paste or putty and allowed to age for a time before using.

Kinds of mortar.

The mortars generally used in masonry work are classified as: (1) Cement mortar, (2) cement-lime mortar, and (3) lime mortar. Cement mortar is one which contains not less than 75 per cent of cement as the cementing medium. Cement-lime mortars are mortars in which the proportions of cement and lime are nearly equal. Lime mortars are mortars which contain not less than 75 percent of lime as the cementing material. The percentage of lime or cement used in a mortar mixture depends largely upon the purpose for which the mortar is to be used. Cement mortars are rarely used in masonry construction except for reinforced brickwork or for work that requires a high crushing strength or for masonry work below grade.

Cement-lime mortar is used for most types of masonry above grade. Lime mortars may be used satisfactorily for nonload-bearing walls, for

load-bearing walls upon which the load is comparatively light, or for walls constructed in sections where weather conditions are not too severe.

The proportions of lime, cement, and sand recommended for mortar mixtures are as follows:

Cement mortar—
- 1 part cement
- Not over ¼ part lime putty
- 2½ to 3½ parts of sand

Cement-lime mortar—
- 1 part cement
- 1 part lime putty
- 5 or 6 parts sand

Cement-lime mortars made with a higher percentage of lime are known as cement mortars and lime mortars. They are mixed as follows:

Cement mortars—
- 1 part cement
- 2 parts lime putty
- 7 to 9 parts sand

Lime mortars—
- ⅕ to ⅓ parts cement
- 2 parts lime putty
- 6 to 7 parts sand

Qualities of mortar.

The quality of mortar depends on its crushing and bonding strength, as well as its workability under the trowel. A higher percentage of cementing material is required to produce a satisfactory mortar with sand of some types.

The working condition of the mortar under the trowel and its adhesion to masonry units determine its suitability for use in laying up brick. A number of conditions may affect the workability of mortar. The brick may be too dry or too wet, or the mortar may not be mixed to the proper consistency. This causes the mortar either to set up too quickly or to spread out and run down the face of the wall. If the brick are too hard and nonabsorbent, a drier mortar mixture must be used. A very absorbent brick requires a more plastic mortar. Climatic conditions also affect the kind of mortar to be used.

Mortar admixtures.

In addition to the regular ingredients, such as lime, cement, and sand, other materials are sometimes used in mixing mortars. Water-

proofing compounds are sometimes added to produce a more dense and waterproof mortar and mineral colors to give the desired shade.

The ingredients used for making mortar should be carefully measured and, if possible, mixed in power mixers. Batch mixing machines of the drum type are made in various sizes to meet the working conditions of small or large jobs. Mechanical mixing permits of definite timing of the mixing process, and hence, produces a uniform type of mortar. Hand mixing is permissible on small jobs. The materials used on the small job should be mixed thoroughly before water is added.

IV. Details of construction.

2. Supports.

a. **Footings.**

b. **Arches.**

c. **Lintels.**

Footings.

Brick was often used for footings of walls and piers in the earlier types of masonry construction. It is still used with satisfactory results in ordinary types of construction, where the footings are properly designed to spread the load they are to carry over the required area. However, since the use of concrete for foundation purposes has become the accepted building practice, most footings are made of plain or reinforced concrete.

Footings may be made with straight sides or with the sides stepped back or corbelled. The standard practice for determining the width of footings for walls and piers is to make the number of courses in the footing equal to the number of half brick in the wall

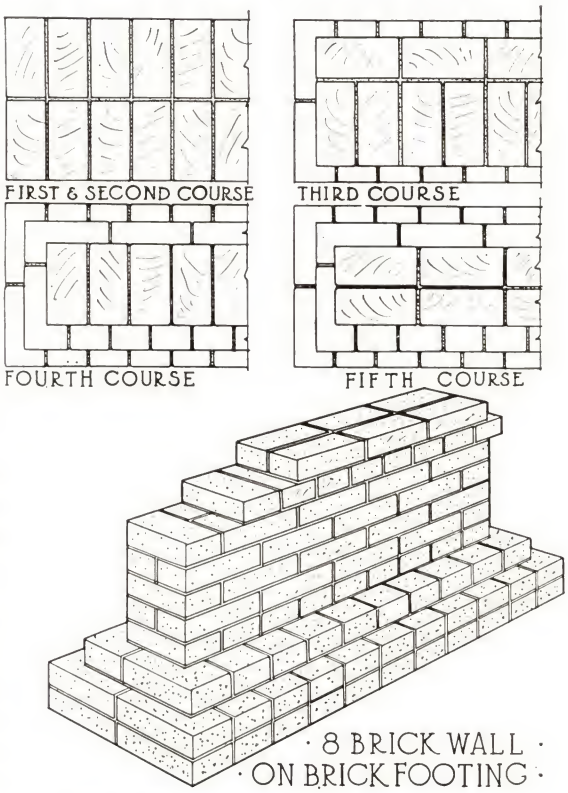


Figure 75.—Brick footing for an 8-inch brick wall.
This illustration shows the method of bonding the various courses in the footing and the wall.

thickness. With this standard as a guide an 8-inch or 9-inch wall should have a 2 course footing, a 12-inch wall, 3 courses, and a 16-inch wall, 4 courses.

It is the usual practice to start the footings with a course of headers. These headers are laid end to end and in some instances the first course is doubled, but this is not a common practice. Figure 75 shows a footing for an 8-inch brick wall in which the first course is started with headers laid end to end.

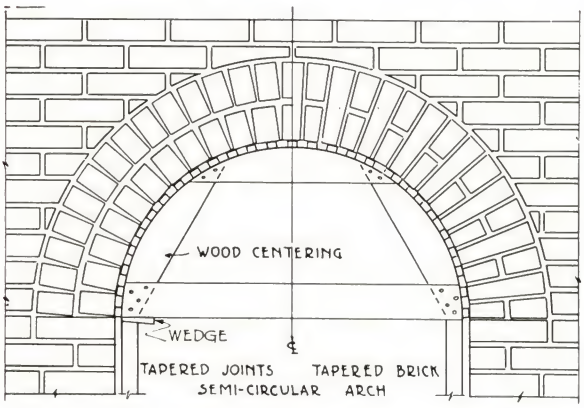


Figure 76.—Semicircular arch over window or door opening.

This illustration shows the wood centering in position and two types of a semicircular arch.

The second course is stepped back and laid up with a brick and a half and the third course, which is the start of the 8-inch wall is laid up with a course of headers. On top of this last course is a course of stretchers having joints extending through the wall.

Arches.

Relieving, segmental, semicircular, and flat arches are the more common types of brick supports over openings in brick walls. However, a steel lintel is probably the most common method of spanning a short opening over which any type of brick construction is to be laid.

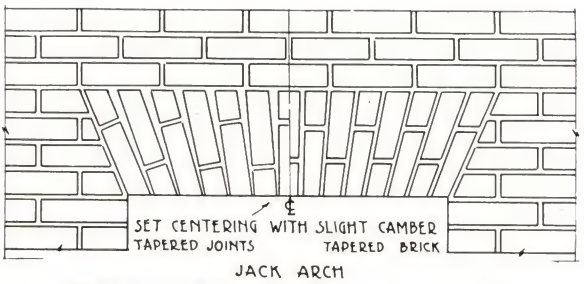


Figure 77.—A flat jack arch in a window opening.

This illustration shows the arch on the left laid up with tapered mortar joints and the arch on the right laid up with tapered brick.

If a relieving or segmental brick arch is used to span an opening, the rule for developing this type of arch is to make the radius equal to the span of the opening, or the rise about one inch for each foot of the span. Arches are sometimes built of cut or molded brick, but more often the regular shape brick are used and the arch laid up in a rowlock course. The variation in the width of the top and bottom of these courses is taken care of by making the mortar joint wider at the top.

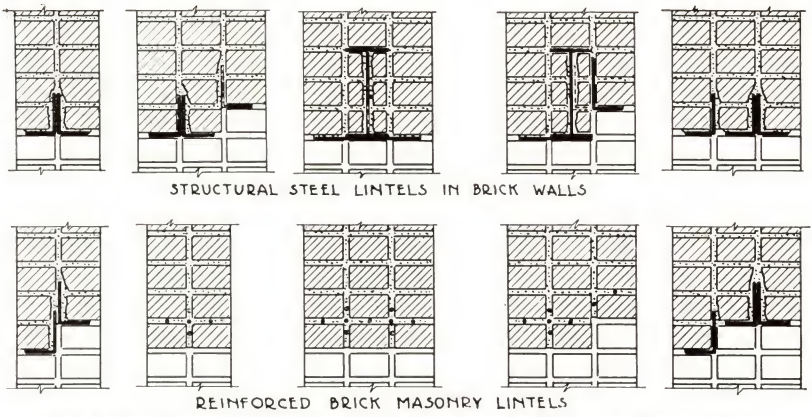


Figure 78.—Flat arches supported with steel shapes and reinforced brick lintels.

Figure 76 shows a semicircular arch laid up of headers in a rowlock position. There are two types of arches in this illustration. The arch illustrated on the left is laid up of regular-shaped brick and the one on the right is laid up of cut brick and the alternate courses are tied together with a cut stretcher. Figure 77 shows a flat or jack arch laid up on one side with regular brick having the ends clipped so as to be straight across the opening, and the other side laid up with molded brick or brick ground to shape.

Lintels.

Openings in brick or tile walls may also be supported by structural steel members or with rods imbedded in the mortar joints of the brick or in the webs of hollow tile. Figure 78 shows a series of flat arches supported upon various steel shapes. Some of the flat arches

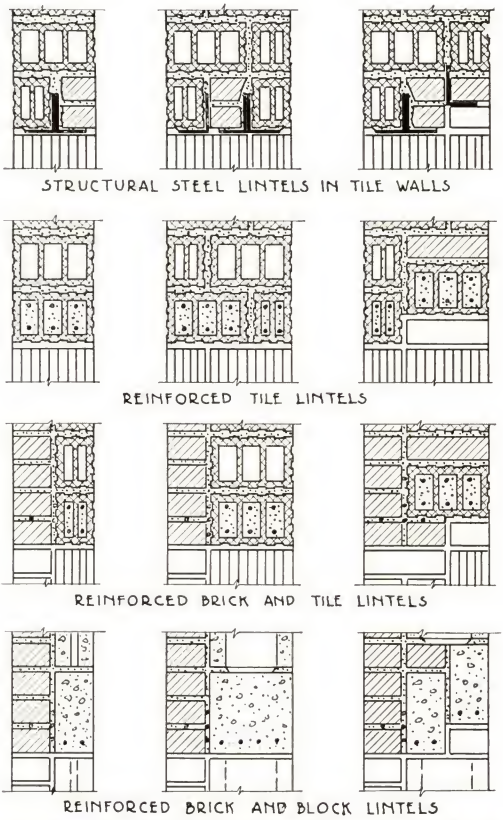


Figure 79.—Methods of constructing lintels over openings in tile walls; also, openings in brick walls backed up with hollow tile.

are constructed of reinforced brickwork, as indicated in the lintels at the bottom of this illustration.

Figure 79 shows the manner in which a reinforced concrete lintel is sometimes used in back of brick arches for the support of the backing masonry and the use of steel shapes and reinforcing rods in hollow tile as lintel supports in hollow-tile-constructed walls

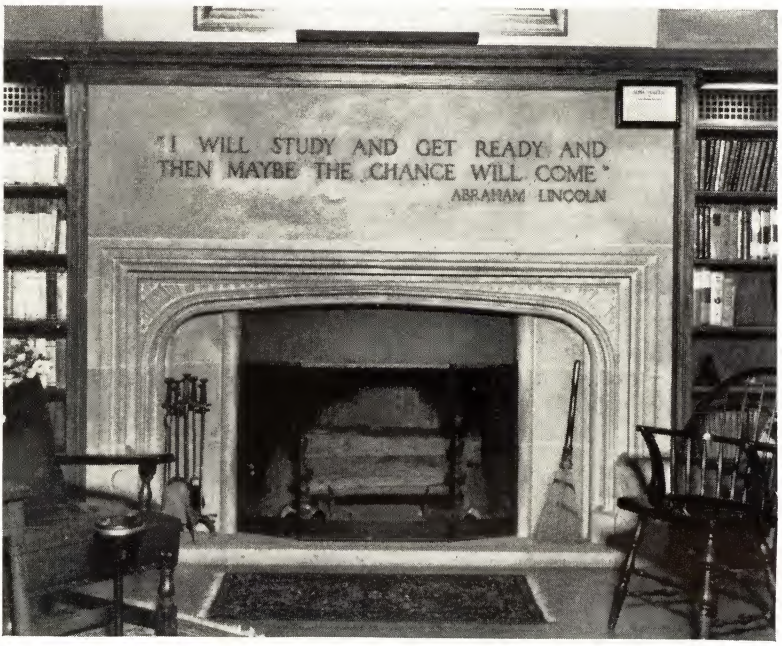


Figure 80.—Fireplace in study lounge of Union Building at Indiana University.

Illustrates a modern adaption of English Tudor style fireplace without mantel shelf. The width of the opening has been reduced by recessing stone jambs. A metal hood is also used to reduce the height of opening to a size appropriate to the room.

* * * * *

IV. Details of construction.

6. Special constructions.

c. Fireplaces.

Antiquity of the fireplace.

The first home fires, forerunners of the modern fireplace, were those kindled on the earth or upon a conveniently placed slab of stone, around which the family gathered to prepare its food. In just what period in our history fires were first used will never be known, but we have evidence that primitive man made use of caves as his first temporary dwelling and built fires at the mouth of these caves not only to prepare food but also to protect his family from enemies. Later, when dwellings were constructed outside of caves, family life centered in one large room in the middle of which a wood fire was lighted. The smoke was allowed to escape as best it could through a hole in the roof or crevices in the wall. This use of fire for heating and cooking was adopted even by the nomads, who built fires in the center of their tents and allowed the smoke to escape through an opening left at the top.

Figure 81.—Brick and oak lintel type of colonial fireplace in house at Plymouth, Mass.

This fireplace was built in 1640 in what is conceded to be the oldest house in Plymouth. The bake oven built into the side all of fireplace is shown at the left. Repairs have been made to the brick lining and face of wall, but much of the original brick remains in the masonry walls of the fireplace, as well as in the chimney stack. The fireplace and oven are still in use.

As more permanent and larger habitations were built and balconies or second floors were used for sleeping quarters, the hearth-stone was moved to the corner of the room and an opening made in the wall to allow the smoke to escape. Later, a stone hood, which sloped back against the wall was added to aid in carrying the smoke out of the building.

Gradually the efficiency of the open fire was increased and eventually the fireplace was constructed in a recess in the center of one of the walls, with its own hood and enclosed flue, leading up to a chimney on top of the wall. As time passed, and more consideration was given to the comforts of living the fireplace was not only improved, but became the central decorative feature of the home.

The value of chimneys was appreciated in England as early as the latter part of the fourteenth century, when they became an ornamental feature in the better homes. Tudor builders gave considerable thought to chimney stacks, producing innumerable patterns in molded brickwork. The beautiful, tall, slender stacks that they constructed to carry away the smoke from the fireplaces are admired by the bricklayer of today and the designs are copied in our present-day homes

Colonial fireplaces.

Our forefathers brought with them the traditions surrounding the construction of fireplaces as they were built on the continent. In adapting these traditions to meet the varying climatic conditions of the new world, it was necessary for them to devise new forms of construction. For instance, in New England, where the winters were more severe than in Virginia and the South and where the building materials consisted largely of native timber, fireplaces were built around a central stack (see figure 81). This stack had from four to six flues, depending on the number of rooms to be heated by individual fireplaces. The bleak remains of some of these central stacks, solidly constructed of brick or stone masonry, and with openings for the mantels on all four sides, are still standing.

Figure 82.—Fireplace in living room of "Wakefield" restoration of the birthplace of George Washington in Virginia

This fireplace, with its massive chimney stack built of brick made by hand on the former Washington estate, is one of several which were constructed in the four chimney stacks to heat all the principal rooms of the house.

Farther south, where climatic conditions were less severe, and where frame construction was used, the chimney stack with fireplace opening was built first at the end or ends of the foundation and the building erected against or between the chimney or chimneys. See figures 82, 83, and 89.

Benjamin Franklin, to whose genius is attributed many of the innovations which added to the comforts of our well being, offered many suggestions on the construction and maintenance of the fireplace and other means of heating. He built a metal stove into the fireplace opening, through the chambers of which air was circulated and warmed by a method somewhat similar to that followed in our modern circulating fireplaces. He also suggested that when the open fireplace was retained the chimney that served it be reduced in size, thus improving the circulation or draft and making the fireplace more efficient.

Count Rumford, an English scientist who published a series of essays on chimneys and fireplaces in 1796, is the one to whom we are most indebted for the improvement in fireplace design and for the rules governing the size of openings and flues. He spent a great deal of time studying the errors of fireplace construction and the principles governing the circulation of gases of combustion. He also gave considerable time to the reconstruction of old fireplaces in accordance with the principles he had developed. Among these principles are the

following: Bringing the back of the fireplace forward and splaying the sides so that a greater amount of heat may be reflected into the room; preventing the loss of some of the heat through the flue in the chimney by narrowing the throat opening in the smoke chamber and placing this opening near the front; and dropping the lintel when it was too high to improve the circulation of gases in the smoke chamber. The rules that Count Rumford laid down in a general way are the bases of the most successful types of modern fireplace construction.

Figure 83.—Side view of two restored houses at Williamsburg, Va.

This shows the manner in which chimney stacks were built independent of the walls of the house and entirely outside of the completed building. The same arrangement of chimney stacks was followed even when the walls of the house were of brick as was done in the brick house shown at the right.

Near the end of the 19th century other means of heating dwellings besides the fireplace came into use. The fireplace lost some of its prestige as a heating medium, but was included in dwelling construction, chiefly on account of its decorative appearance and its cheerful associations. On the other hand, the fireplace, as it was developed by American architects, during the past 50 years, has become one of the most ornamental and beautiful features of the home. Probably in no other country have so many types and styles of fireplaces been constructed as in the United States. Fireplace mantels built of brick, stone, tile, and wood are illustrated in figures 80, 84, 85, and 90. Although the ornamental mantel facings of fireplaces may be of other materials than brick, the chimney and its foundations are invariably of masonry construction.

Figure 86 shows an elevation and cross section of a fireplace and chimney stack suitable for the average home.

Foundation.

Because of the mass and consequent weight of the masonry to be supported, a foundation covering an area sufficient to safely carry the

Figure 84.—Modern colonial brick fireplace set in white-painted wood-paneled wall. Carl A. Ziegler, architect.

Simple type of brick fireplace in a room of moderate size.

load of the fireplace and the chimney should be constructed. Building the foundation the full size of the fireplace makes it possible to construct an open ashpit and other flues on the same foundation.

The footings for chimney stack may be made of brick or concrete, but in either case, the footings should be reinforced with steel rods and designed to transmit the load over an area that will not exceed the normal, safe-bearing capacity of the soil.

Dimensions of fireplaces.

The fireplace proper consists of an opening, a throat, and a smoke chamber and flue, all of which must be dimensioned in proper relation to each other. A fireplace with too large an opening for its flue is apt to smoke and an incorrectly constructed throat or smoke chamber may make even a properly proportioned fireplace and chimney smoke.

Within certain limits, the size of the fireplace opening should be proportioned to suit the size of the room in which it is built. However, two qualifying factors should be kept in mind: (1) That a fireplace opening in an ordinary-size house should never be made over 2 feet 6 inches in height, regardless of the size of the room; and (2) that except in the smallest of rooms the width of the fireplace should be a little greater than its height.

Figure 85.—Brick fireplace with delft tile facing set in natural wood paneling in basement recreation room.

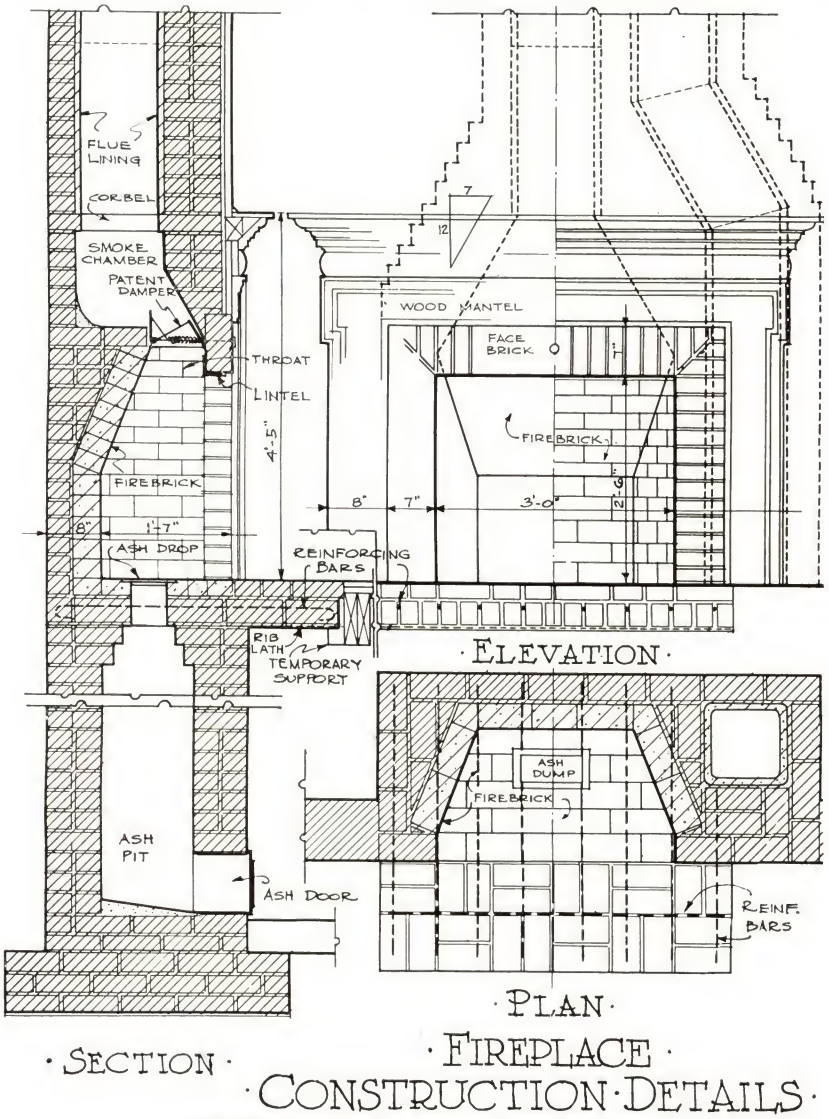


Figure 86.—Working drawing of a brick fireplace.

The elevation and section view gives the dimension of the fireplace opening, the size of the flue, and the method of laying up the brickwork. The plan and lower sectional views give the dimensions of the hearth and the foundation footings.

Table I shows the correct proportions for various sizes of fireplaces suitable for the rooms of residences.

Although chimneys may be built without flue linings, it is necessary to make the walls at least eight inches thick, using firebrick for the inner course. It is generally conceded in modern building practice that flues should be lined with fire clay flue lining and many city building codes require this.

Table I.—Dimensions of fireplace openings including width, height and depth

Finished fireplace opening			Suggested size of flue lining (in inches)	
Width (inches)	Height (inches)	Depth (in inches)	Rectangular Flue Linings (inches)	Round Flue Linings (inches)
24	28	16	8½ x 8½	10
28	28	16	8½ x 13	10
30	30	16	8½ x 13	12
34	30	16	8½ x 13	12
36	30	16	13 x 13	12
40	30	16	13 x 13	15
42	30	16	13 x 13	15
48	33	18	13 x 13	15
54	36	20	13 x 18	18
60	39	22	18 x 18	18
72	40	22	18 x 18	18

Commercial flue linings are made either round, square or oblong. While the round flue is the most efficient type to use in residence construction, the square or nearly square flue, with rounded corners, is generally used on account of the greater ease with which it can be built in the chimney stack. These flue linings are made in sizes that permit them to be built in without much cutting of brick. Because the gases in a flue circulate in the center and do not fill square corners, square or rectangular-shaped flues should have a little more area in their cross-section than round flues. If two flues occur in the same chimney stack, it is permissible to place them side by side if the joints are staggered. Wherever there is room, however, four inches of brick should be used between all flue linings. Table II shows the dimensions of standard rectangular and round flue linings.

Figure 87.—Terra cotta or fire-clay chimney tops.

Molds for making chimney top shown at left and at the right a finished top.

The smoke chamber.

As previously brought out, there is a definite relationship between the area of the fireplace opening and the size of the flue. The smoke chamber leading from the fireplace to the flue should always be made full width at the opening, and sides should be sloped up from the smoke shaft to the flue at an angle of not less than 45° and should be reasonably smooth and free of rough projections. Table II also shows the dimensions of standard flue linings suitable for residential fireplaces.

Most flue linings are 2 feet in length, although some of the larger round linings are made 2½ feet in length.

The lintel at the top of the fireplace opening should be placed 4 inches or more below the top line of the back or the under side of the throat opening regardless of whether a simple damper cover or cast iron throat is used.

Figure 88.—Chimney stack of college buildings, Cranbrook, Mich.

In this structure the walls and chimney are laid up with brick having a moderately rough natural-textured surface and a fairly wide range of color. The chimney is constructed of the regular-shape brick, except for the limestone trim at the intake courses and chimney cap and the roofing tile used to cap the buttress at sides and back of chimney. The ornamental detail at top of chimney is produced by projecting the brick beyond the normal face line.

Although fireplaces constructed with only 4 inches of brickwork between the mantel face and the throat frequently prove satisfactory, it is better to make this brickwork at least 8 inches thick up to the level of the throat. From this point the fireplace may be readily corbelled back and the thickness of the chimney breast reduced. Although chimneys are frequently built with only 4 inches of brickwork on the outside of the flue lining, an 8-inch thickness is recommended, especially in the colder northern sections of the country.

The flue should always be taken off from the smoke chamber directly over the center of the fireplace opening, even though the flue is carried over at an angle to the side of the chimney stack a few feet above where it leaves the smoke chamber. The angle of this slope should never be made more than 45 degrees to the horizontal. Where an angle run is jointed to a straight run, the joint should be mitered by cutting the sides of both pieces of flue lining so that the sectional area will be the same throughout the length of the flue.

Table II.—Dimensions of standard flue linings suitable for fireplaces

Rectangular		Round	
Outside dimensions (inches)	Inside cross sectional area (square inches)	Inside diameter of flue linings (inches)	Inside cross sectional area (square inches)
8½ x 8½	52. 5	10	78. 5
8½ x 13	80. 5	12	113. 0
8½ x 18	109. 6	15	176. 7
13 x 13	126. 5	18	254. 4
13 x 18	182. 8	20	314. 1
18 x 18	248. 0	22	380. 1

Methods of constructing fireplaces.

There are two methods of constructing fireplaces: Under the first method, a rough opening is built about nine inches wider than the proposed fireplace and high enough to provide for both fireplace and smoke chamber, which is built in later. The second method calls for the construction of the fireplace as an integral part of the flue or chimney. Either method is satisfactory when the work is properly done. The first method is more often used for fireplaces of the larger types having ornamental facings and chimney breasts. The second method is used for the smaller types of fireplaces, such as are constructed in the average small or moderate-sized house.

Figure 89.—Brick chimney stack at Williamsburg, Va.

Shows the method of constructing a chimney for a frame residence. The fireplace openings on first and second floor have been "bricked up."

Fireplace linings.

Fireplace linings should be constructed either of firebrick or a reasonably high refractory shale brick, but they should never be laid up of ordinary common brick. Unless a rough and somewhat rustic appearing lining is desired, the brick for this purpose should be selected so that they will be uniform in size and free from such imperfections as warping and broken edges. The mortar joints of fireplace linings should be tooled or slightly concave or should be struck and pointed flush. Mortar joints should seldom be more than one-half inch wide. All spaces between the lining and the enclosing brick masonry of chimney stacks should be filled in with brick and mortar as the lining is built.

Hearths.

Both front and back hearth may be built of brick laid flatwise to whatever pattern is desired. These brick are bedded in mortar spread on supporting arch or concrete slab, and the joints between them are filled with a mortar grout.

Damper.

In the modern fireplace a metal regulating damper is a necessity. The damper is kept open when the fire is burning to insure a draft

and to prevent smoke from entering the room; and when there is no fire in the fireplace the damper is closed to prevent drafts from taking warm air from the room and to protect the fireplace from snow or rain or dropping soot. There are a number of types of dampers, all of which work on the moving throat principle which permits them to be opened and closed by a lever. The doors of some dampers are hinged or pivoted at the bottom. In others, the pivot is in the center. In most instances dampers are fitted in a flanged frame, the front of the damper being used for the soffit of the flat brick arch over the fireplace opening. Other types of dampers are constructed independently of the angle iron used as a structural lintel over the fireplace opening.

Ash door.

There are various types of ash doors which are built into the hearth of the fireplace and which permit the ashes to be dropped into the ash pit. Some of these ash doors are constructed so that no dust will come back into the room when the ashes are dumped into the pit.

Figure 90.—A large richly carved stone mantel with brick fireplace lining laid up in herringbone pattern.

A fireplace suitable for large rooms of homes or club buildings. It is a modern adaption of the more ornate Italian Renaissance style in which the richly carved mantel may be accurately reproduced in artificial stone made of cast cement.

Circulating fireplace.

Metal ducts, for warming and circulating air, are sometimes built into the masonry of a fireplace. Some of these circulating fireplaces take the air from the room, but others draw fresh air in from the outside. A few of the heating and circulating devices are complete units in themselves.

"Where glowing embers through the room
Teach light to counterfeit a gloom."

Milton—"Il Penseroso."

IV. Details of Construction.
6. Special constructions.
***g*. Kilns.**
***h*. Ovens, and glass tanks.**
***i*. Furnaces.**

Introduction.

Refractory materials in the form of brick shapes which withstand high degrees of temperature are used for the linings of furnaces, ovens, kilns, and tanks for the production of steel, glass, lead, copper, tile, cement, lime, and other materials.

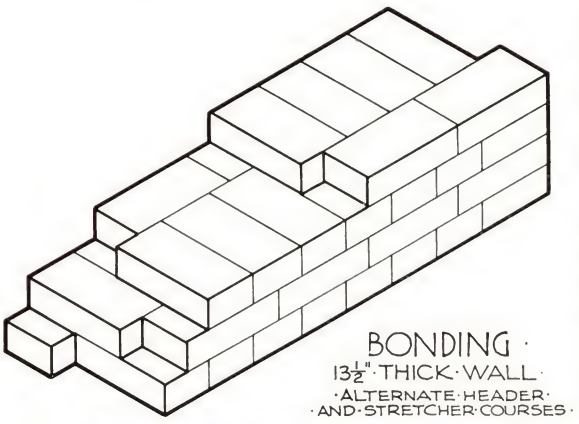


Figure 91.—Structural bonding in a refractory brick wall.

This illustration shows the method of bonding a 13½-inch firebrick wall by using headers in alternate courses.

The brick used for these linings are made of a variety of materials, such as fire clay, alumina, silica, magnesite, and other compounds. They are molded into brick shapes and fired in the same manner as common or face brick. The type of clay used, process of manufacturing and firing temperature produce a material with varying characteristics. Brick made of fire clay will withstand a temperature of about 2200° Fahrenheit and those made of alumina will withstand approximately 3200° Fahrenheit, while other materials used for refractory brick have withstood temperatures of a much higher degree.

Refractory brick are larger than standard masonry brick, usually 9 by 4½ by 2½ inches in size. Larger sizes are made, such as 9 by 6 by 2½ inches and 9 by 12 by 3 inches. Special shapes are also made for different purposes, such as the lining of

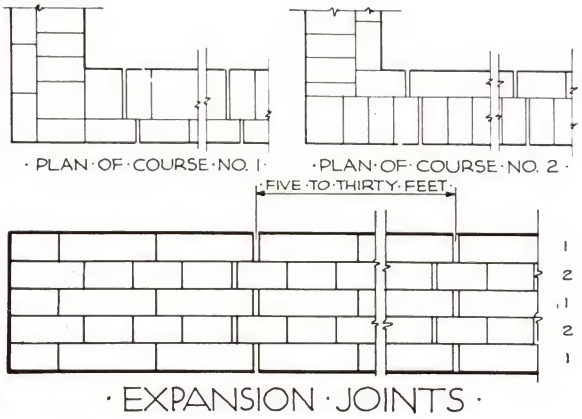
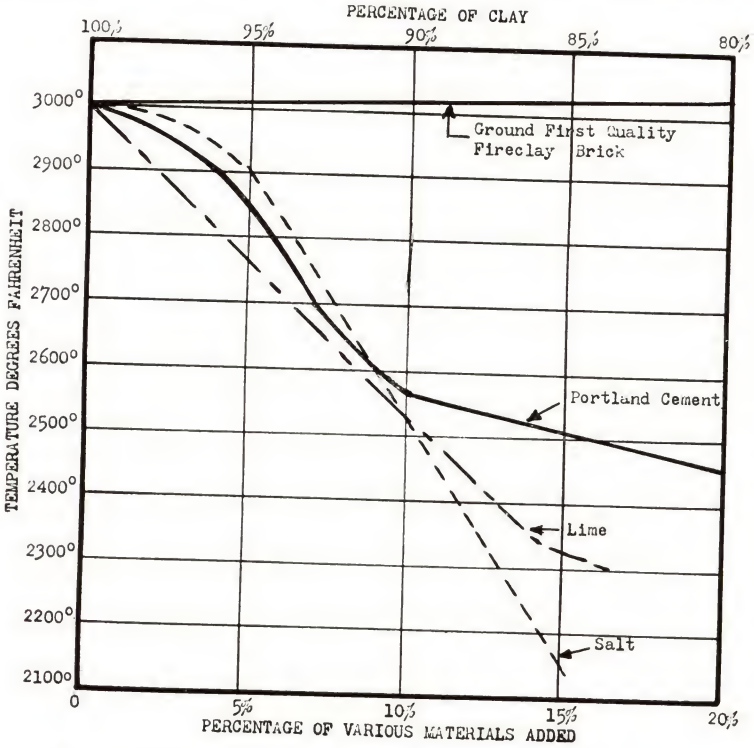


Figure 92.—Expansion joints in a refractory brick wall.

The plan and elevation drawings in this illustration show the method of placing expansion joints at the corner and at regular intervals in the surface of the wall.

rotary kilns and the sides and arches of ovens. Some of the refractory material is made in the form of blocks, such as those used in the lining of cupolas.

Refractory brick are also used for insulating purposes. Properly insulated walls retain much of the heat within the furnace or oven.



Fusion points of mixtures of a Plastic Fireclay and other materials.

Diagram I. Effect of mixing lime, cement, or salt upon fusion point of fireclay mortars.

Refractory brick, which are resistant to the action of acids, are often used in retorts and acid towers employed in the production of chemicals.

How refractory materials are laid up.

Practically the same methods are employed in laying up refractory brick as in laying up common masonry brick. The walls in which refractory materials are used are of various thicknesses. For this reason, the headers are placed on alternate courses in order to thoroughly bond the wall together. Refractory brick are cut similar to common brick and must be properly shaped to make a close fit. Very little space is left between the brick shapes for mortar joints. See figure 91.

One thing should be kept in mind, however, in laying up refractory material. Because they are subjected to high temperatures and ex-

pand considerably, refractory materials are laid up with spaces or openings left in the walls. It is the practice to allow from $\frac{1}{16}$ to $\frac{5}{16}$ inches per foot of space for expansion of the brick. These expansion joints are usually placed at intervals of from 5 to 30 feet, depending on the length of wall and the degree of heat to which the wall is subjected.

In lining steel stacks or furnaces enclosed in structural steel castings, one-half inch of loose insulating material should be placed between the refractory lining and the steel shell to take care of the expansion of the brick. Figure 92 shows the method of laying up a wall and bonding it with alternate header courses. Expansion joints are indicated in this illustration.

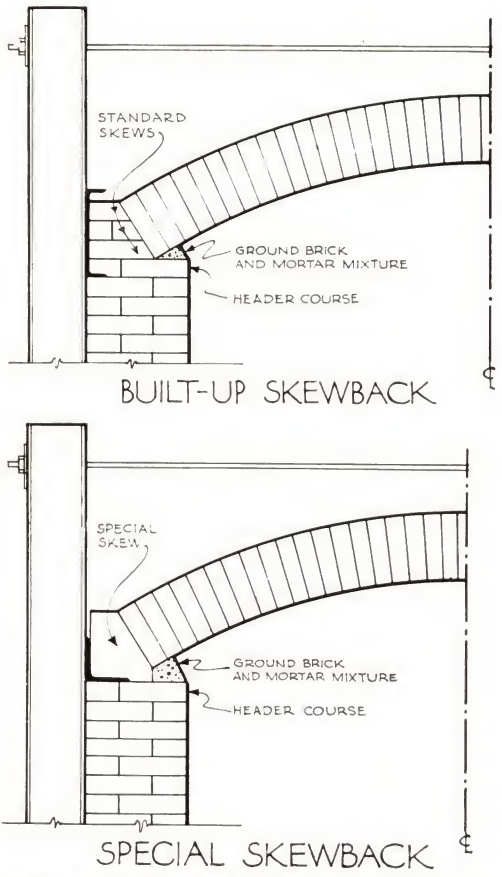


Figure 93.—Two methods of laying up skewbacks in a refractory brick arch.

Mortars.

In laying up refractory brick finely ground fireclay or other heat-resisting mortar materials are used. The brick are laid with either a troweled or dipped joint, and very little mortar is used in the joints. Finely ground fireclay, used for mortar in laying up firebrick, has a very high fusion point. The addition of other materials, such as lime, cement or salt, may greatly reduce the refractoriness of the mortar. Diagram I shows the effect of mixing fireclay with Portland cement, lime, and salt in various quantities upon the fusion points of mortar.[1]

Construction of arches over tanks.

The same methods are used in determining the radius of a segmental arch, laid up as the roof to an oven or furnace, as are used in determining the radius of a relieving arch over a window or doorway in a

[1] Modern refractory practice. Harbison-Walker Refractories Co., Pittsburgh, Pa.

brick building. The centering for these arched roofs is put in place by the carpenter. The two most common types of arch construction are: (1) That in which the arch proper rests on a steel angle or channel fastened to upright I-beams; and (2) that in which the arch rests on the wall without steel support. One might be termed skele-

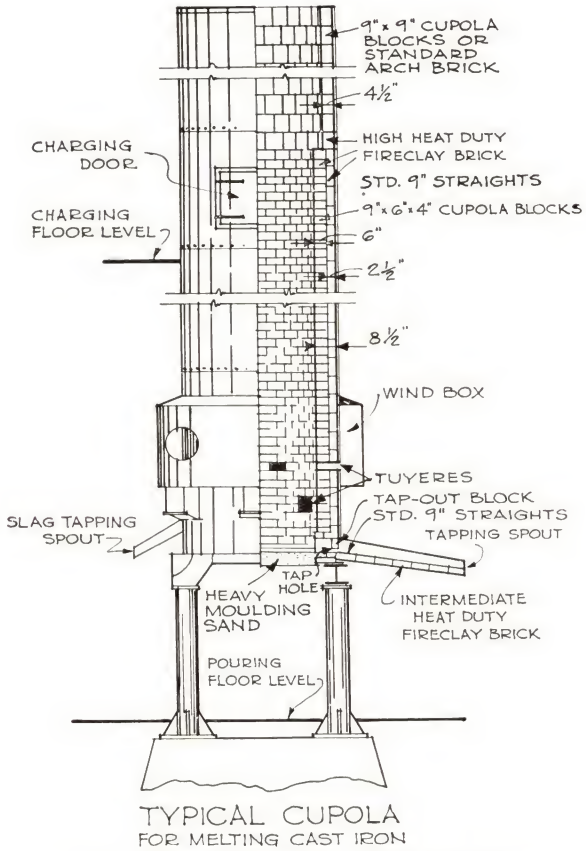


Figure 94.—Typical cupola for melting cast iron.

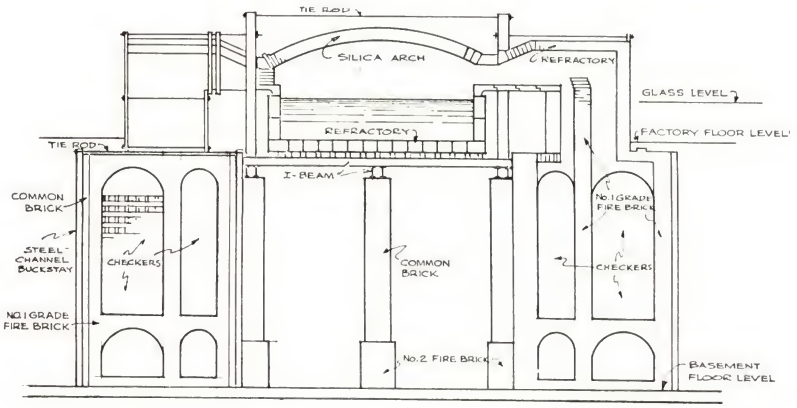
ton steel construction and the other load-bearing-wall construction. Figure 93 illustrates the two types of arch construction over an oven or tank.

The cupola furnace used for melting cast iron is made of a steel shell riveted together and lined with special circular-shaped refractory cupola blocks. Figure 94 illustrates a typical steel shell cupola lined with two tiers of fireclay brick from the lower part of the cupola to the top of the charging door. Special shapes of fireclay blocks are used for the tuyeres and tap-out block. The force draft chamber shown in the section drawing opens into the cupola at a point about one-fourth of the distance to the top of the charging floor level.

Other uses of refractory brick.

Firebrick are used for lining circular continuous kilns used in the production of lime, cement, and plaster. These are circular steel shells lined with various thicknesses of radial firebrick.

Firebrick are also used for the lining of blast furnaces, ceramic kilns, copper furnaces, electric furnaces, gas plant generators, super-



CROSSECTION
REGENERATIVE · TYPE · GLASS · TANK ·
PRODUCER GAS FIRED

Figure 95.—Regenerative type of glass tank.

This cross section shows the use of various masonry materials, such as common brick, refractory brick, and special refractory blocks.

heaters, glass ovens, heating furnaces, incinerators, oil refinery stills, roasters, and sulphite furnaces. See figure 95.

Specially trained bricklayers with a knowledge of these various processes are needed in the various industries, not only for the original construction but also for the maintenance of the plant.

* * * * * * *

V. Drawing.

3. Reading working and setting drawings.

Preliminary.

The drawings for a house or other type of building, such as a garage, furnished by the architect or builder, are commonly called "plans." This set of drawings consists of floor plans, elevations, and sections, together with a number of detailed drawings of the proposed building.

Elevations and plans.

The outline drawings showing the dimension lay-out of the several sides of the building are referred to as the "elevations." These elevations are designated as "front," "rear," and "side" elevations. On these elevations are given the location and dimension of openings, such as windows and doors, the position of chimneys, and the slope of the roof or dormers. The floor plans show horizontal sectional drawings of the building taken just above the sill level, usually three feet above the floor. The building plans show the location and size of openings, the thickness of walls, and the conventions which indicate the type of construction, as well as the position of the partitions and the size of rooms.

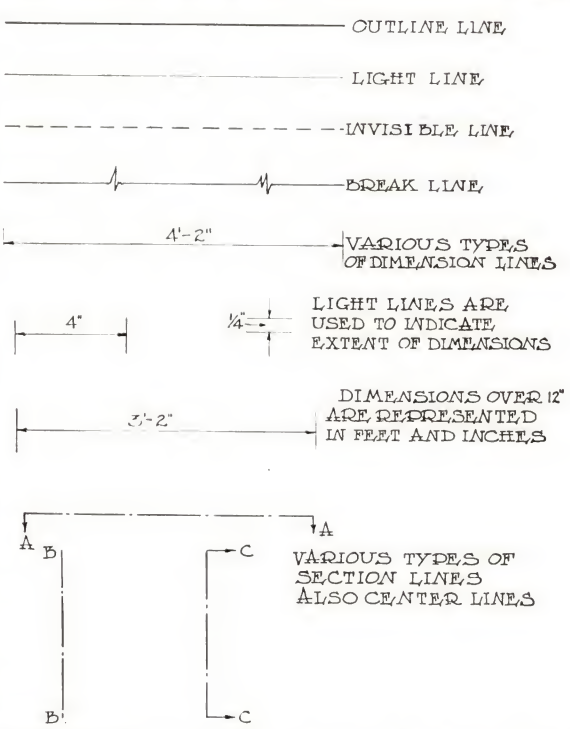


Figure 96.—Conventional lines used by draftsman in making working drawing.

Vertical sections.

Drawings of vertical sections inside the wall lines and through the center of the building show sill and ceiling heights, and the position of window openings and other detailed information needed by various craftsmen. The elevations and plans are usually drawn to a definite, reduced scale from the actual size of the building. For a medium sized building this reduction is usually figured on a scale of ¼ inch to 1 foot of the actual dimensions. If the building is rather large, the

scale is reduced to ⅛ inch to 1 foot of actual dimensions. The details of the construction of the building are shown on enlarged sections of some particular part of the floor plan or on a cross section of the wall. These sectional drawings or details are usually drawn to a scale of ¾ inch or 1½ inches to 1 foot of actual dimensions. Full-size details of the more important trim of the building are sometimes included in outline form.

Lines and symbols.

Figure 96 illustrates the use of the conventional lines on a set of drawings. It will be noted that the heavy continuous line is used to designate outlines of the building as well as the construction features shown on the plans, elevations, and sections.

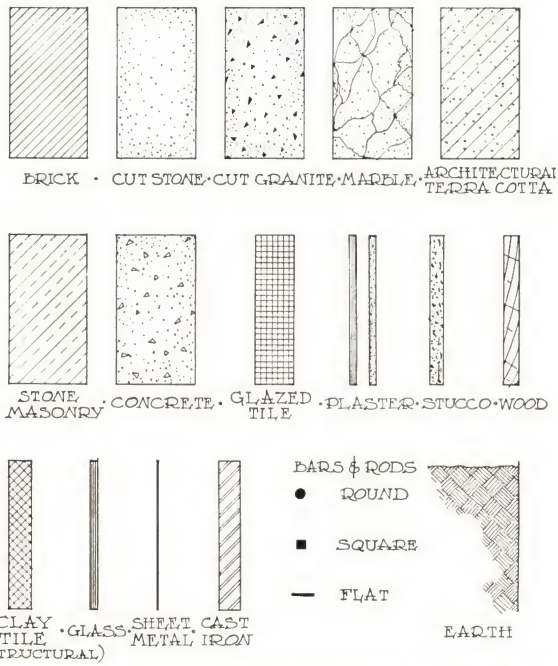


Figure 97.—Conventions used by the draftsman to designate the various building materials.

The broken line is used to indicate an opening or a part of the construction that is below or above the horizontal plane at which the section is taken and therefore would not otherwise be apparent on the plan. Light lines are used for dimension lines and to indicate the position and outline of supelementary features, such as brick jointing and conventions designating various materials. As shown by the illustration, the ends of dimension lines are indicated by arrow points. The distance between these points is given on the lines in feet and inches. All dimensions over 12 inches are represented in feet and inches. Although the approximate distances can be determined by using the scale on the drawing, this method is not accurate enough for construction purposes. The mechanic may make an error in measuring the distances, or the paper on which the drawing has been made may have contracted or expanded slightly, thus giving an inaccurate reading.

The dot and dash line is used to designate the place at which the

section illustrated on a drawing is taken. The arrow points placed at the end of these section lines show the direction in which the section is viewed. The break line, illustrated in figure 96, is used to indicate a termination of part of the construction on the drawing. The break line is used on plans, elevations, and sections to illustrate construction details in a condensed form. The break line does not affect the dimensions between definite points.

Figure 97 illustrates the conventions used to represent the common building materials in both section and plan. It will be noted that a series of light diagonal solid lines drawn through a section of the wall is used to represent brick in plan. Hollow tile is indicated in section by lines running diagonally with the face of the wall. Diagonal lines are more generally used for this purpose than rectangular cross hatching. Glazed structural units, such as terra cotta or glazed brick, are customarily indicated on drawings by cross parallel lines. Specific symbols are used to represent other materials such as glass, sheet metal, cast iron, plaster, stucco, concrete, and wood, as indicated in figure 97.

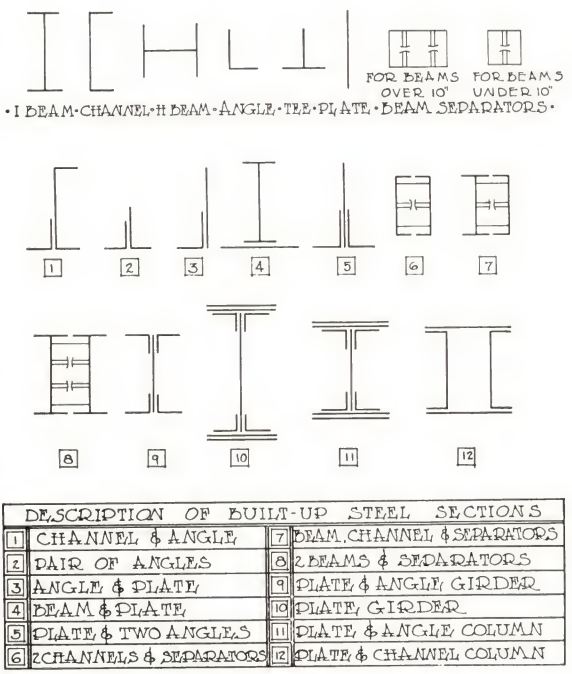


Figure 98.—Conventions used by draftsman to designate various plain-rolled and built-up sections of structural steel shapes.

Figure 98 illustrates the standard steel structural shapes and combinations commonly used in connection with brickwork. It shows, for instance, that the I-beam, channel, and angle irons are used over openings or for girders supporting floor beams, and that in other instances combinations of steel members, such as channel and angle irons, are riveted together, or girders are made up of steel plates and angle irons and used for supporting brickwork.

Figure 99 illustrates the various ways in which interior and exterior doors and several types of windows and sections of wall construction are indicated on plans. The bricklayer will find it necessary to refer

to this figure in interpreting blueprints which show wall construction, position of openings, and other building-construction details.

Working drawings of a 2-car brick garage.

A series of eight plates illustrating the working drawings of a 2-car garage is presented in this section of the bulletin as figures 100 to 107.

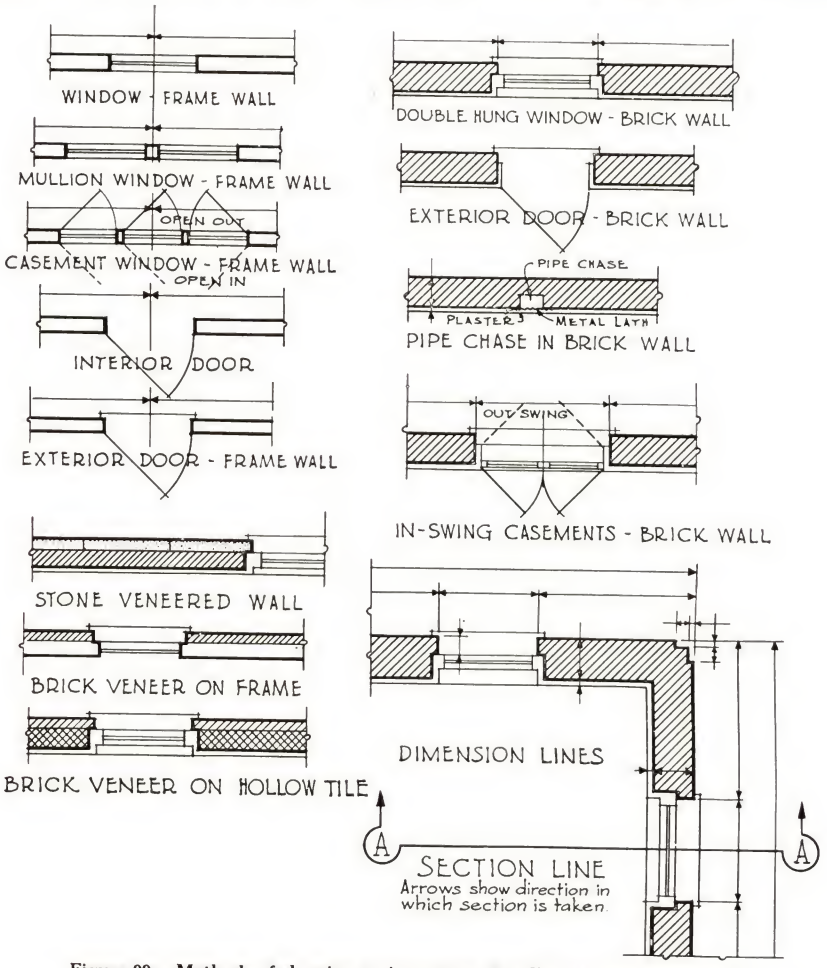


Figure 99.—Methods of showing various types of wall construction on plan.

Figure 100 shows the foundation plan and gives the dimensions of the brick foundation walls. In addition, the drawings show the footings, a section through the concrete floor, and the manner in which the batter boards are set for laying out the foundations of the building. The locations of these batter boards are secured from a plat plan, or survey which indicates the property lines and the position of the building in relation to these lines. This drawing further shows the foundation plan, wall section, and the elevation of the pier.

Figure 101 shows a floor plan taken a few feet above the grade, as well as enlarged sections of the jambs and piers of door openings. The driveway doors of this garage are equipped with sectional over-

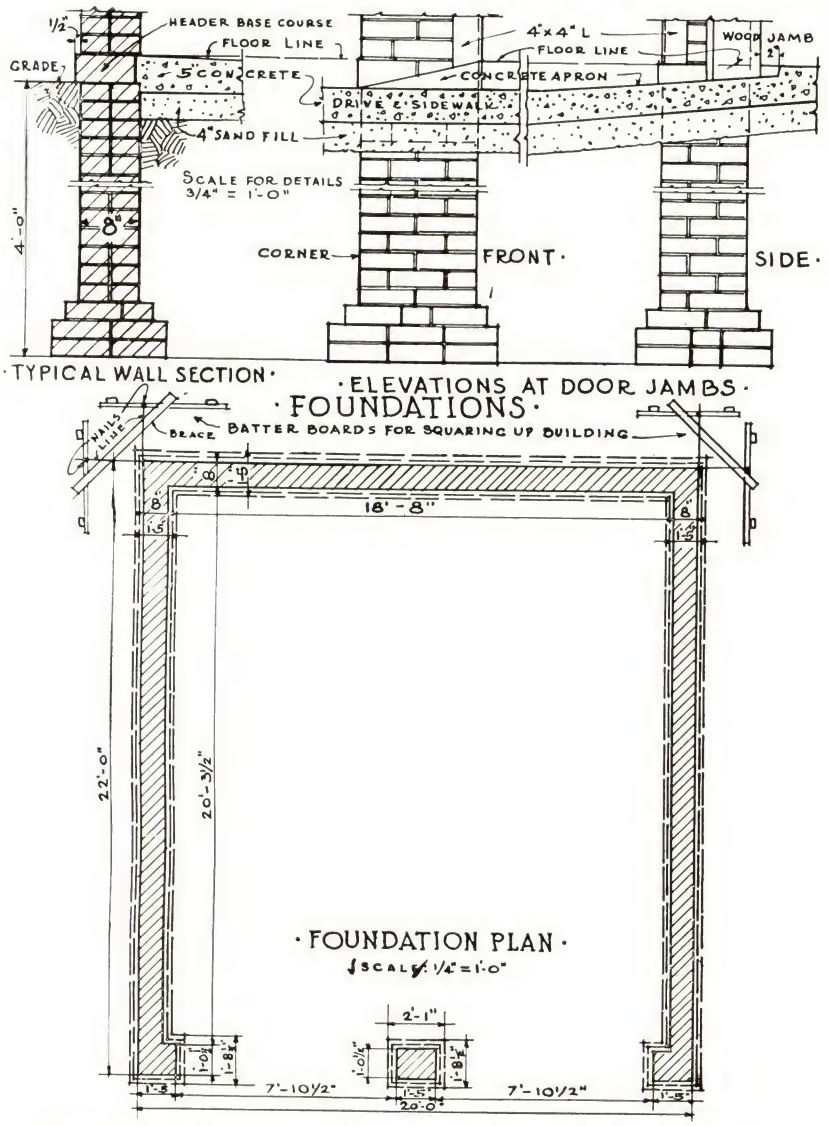


Figure 100.—Foundation plan and section of wall and piers constructed of brick.

Batter boards set up for laying out the work are shown on this drawing.

head sliding doors, as illustrated in a section detail of this drawing. The pier and jamb sections indicate the manner in which corner protection and door track fittings are anchored into brick masonry. As shown in figure 106, the walls of the garage are not plastered on the

inside, so the inside face of the wall has finished mortar joints. The specifications which accompany this set of drawings would give this information.

The diagonal line drawn on a floor plan, as indicated in figure 101, shows the manner in which the floor is to be sloped to the drain.

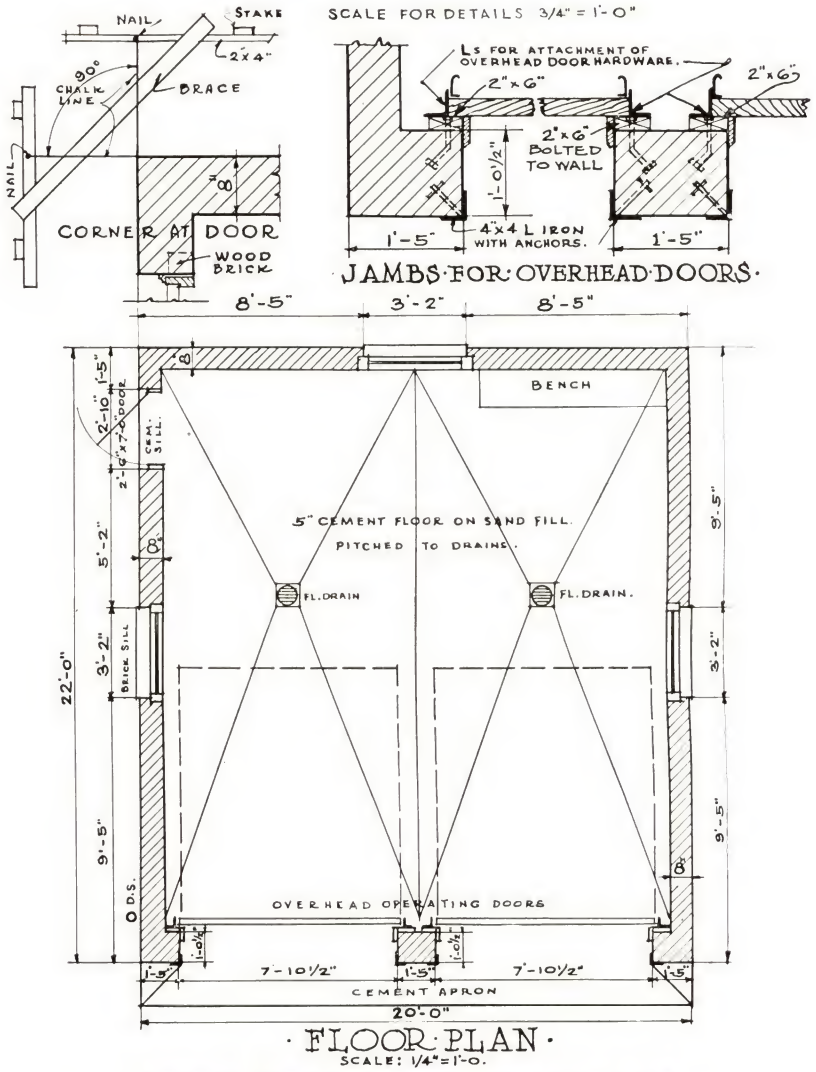


Figure 101.—Plan of 2-car garage and details of door jambs.

This figure also indicates a section of the brick sills and how they are laid up. The door sills under the sectional doors and the apron in front of the wall are made of cement and the convention for this material is used in indicating the method of construction in figure 103.

Figure 105 shows the roof framing plan. This drawing will be of

particular interest to the carpenter, and the bricklayer will refer to the drawing only to find out the location of bolts to be built into the wall for the purpose of anchoring the roof plates.

Figure 102 shows drawings of front and rear elevations of the finished garage. These drawings indicate by dimension lines the

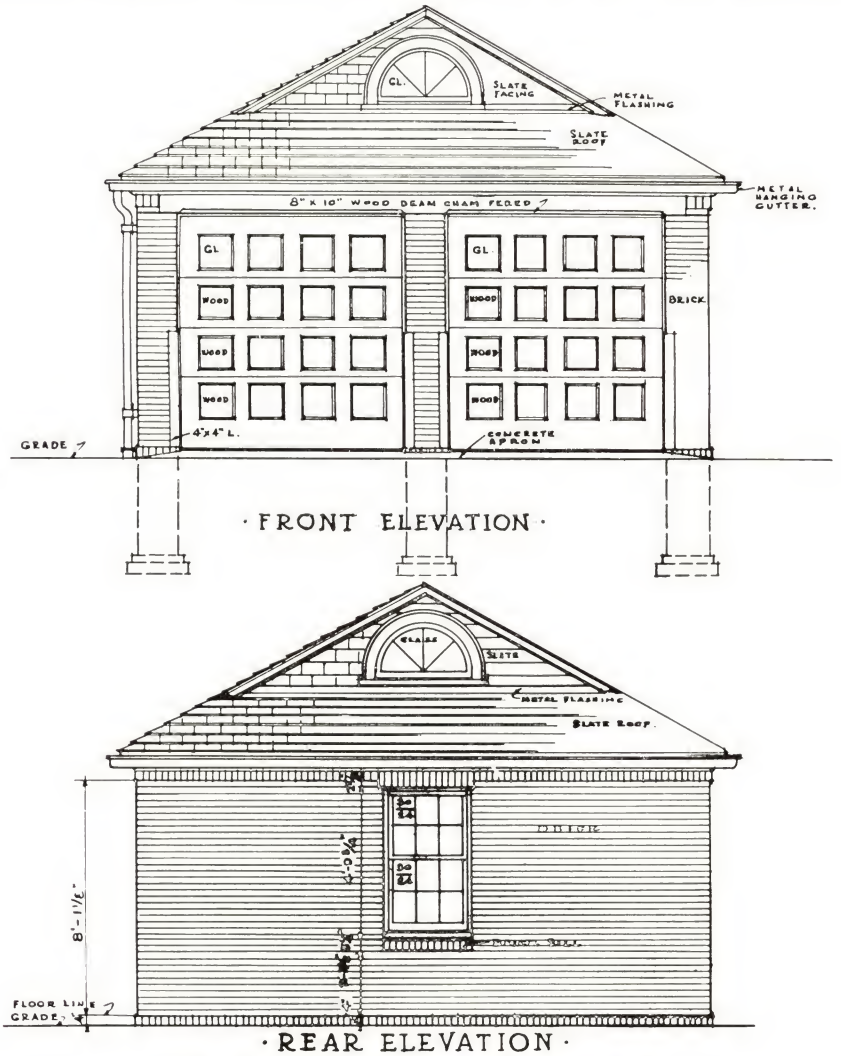


Figure 102.—Front and rear elevations of 2-car garage.

height of the walls above the grade line and the height and position of windows. The drawing also indicates that soldier courses are used for window sills and lintels, as well as for a decorative base and cap courses. This drawing also indicates that the lintel over the doorway may be either of wood or brick.

Figure 103, to which it will be necessary to refer in connection with figure 101, shows alternate types of construction of the lintel over the

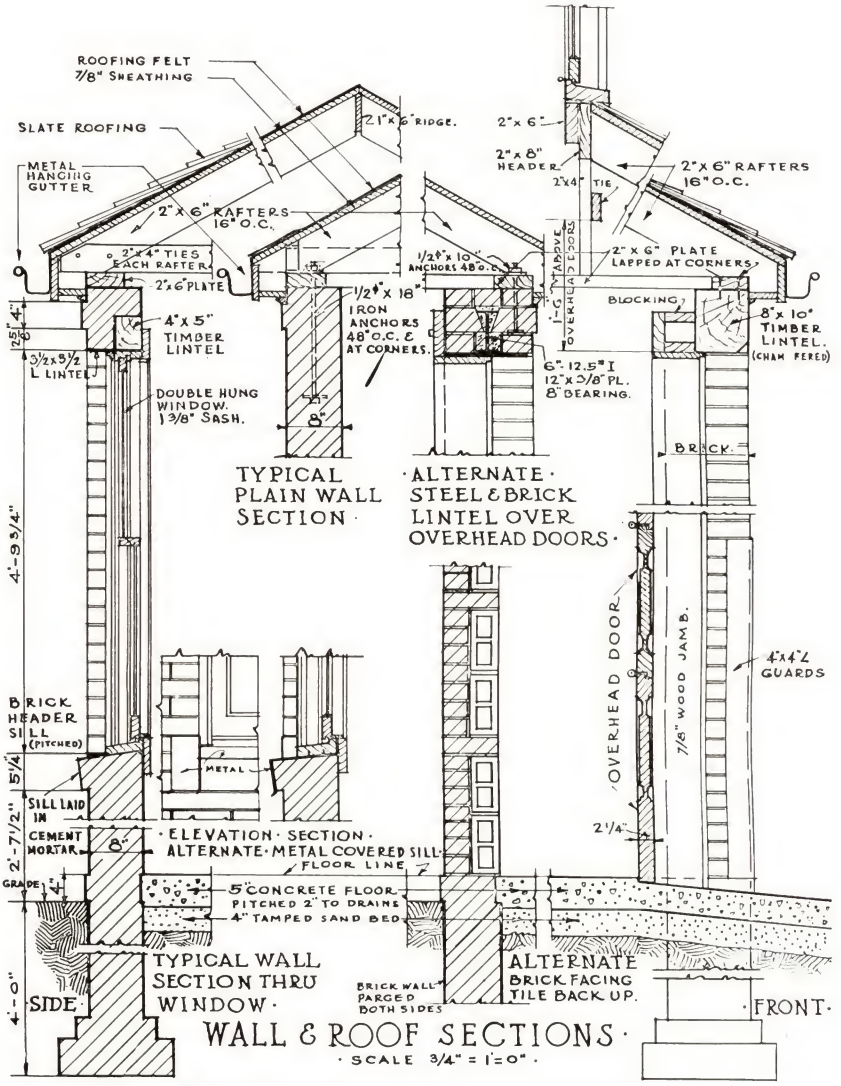


Figure 103.—Enlarged detail sections through various parts of a brick wall.

Alternate section is included showing the wall backed up with tile.

doorway. In one case a heavy beam is used, and in the other an I-beam and plate are used for supporting the lintel.

Figure 107 shows the left side elevation and a perspective drawing of the completed building. The perspective drawing gives a better idea as to how the finished structure will appear. The right side elevation is the same as the left side, except that the door has been omitted.

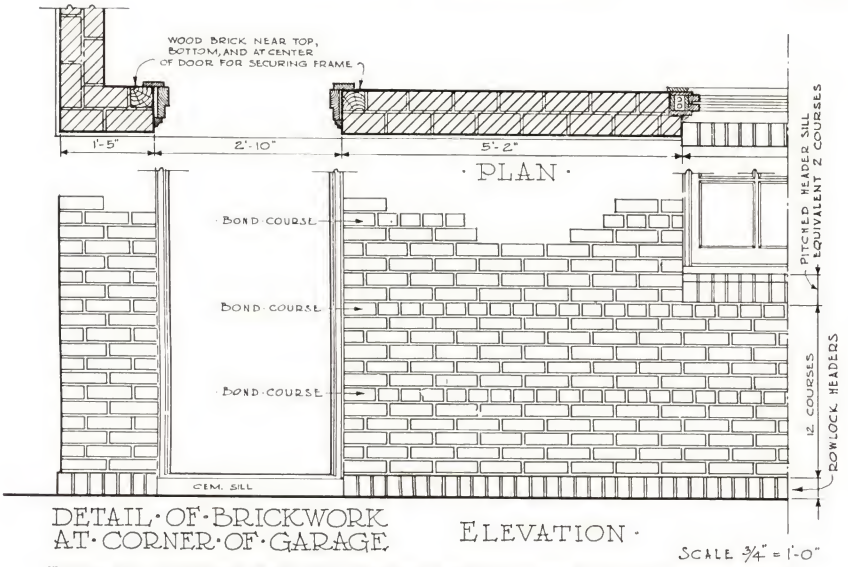


Figure 104.—Enlarged detail of wall showing brick courses laid up in common bond.

This elevation drawing shows the height of the wall, the position of the window, and the type of sill and lintel used. It will be necessary to refer to sectional drawings appearing on other plates to determine the structural details of sills, lintels, and jambs.

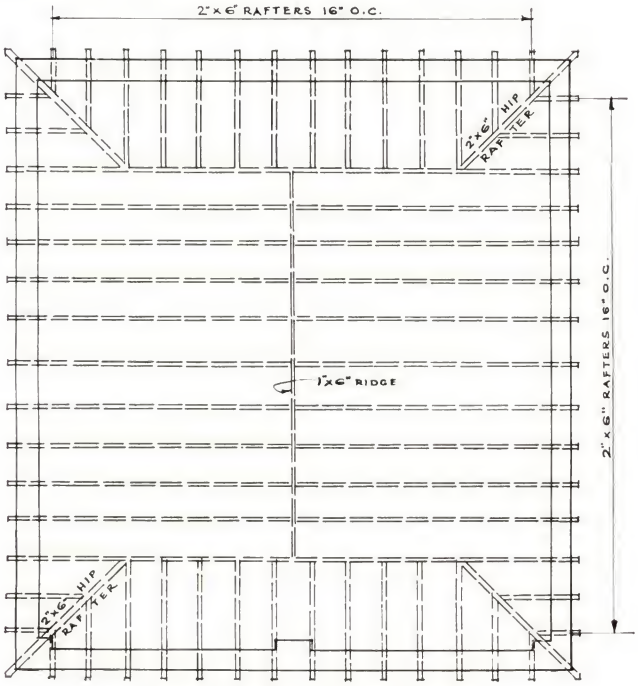


Figure 105.—Plan of the roof framing.

Figure 106 shows a cross section and a longitudinal section through the building. These sectional drawings give additional information as to the construction of walls and the framing of the roof.

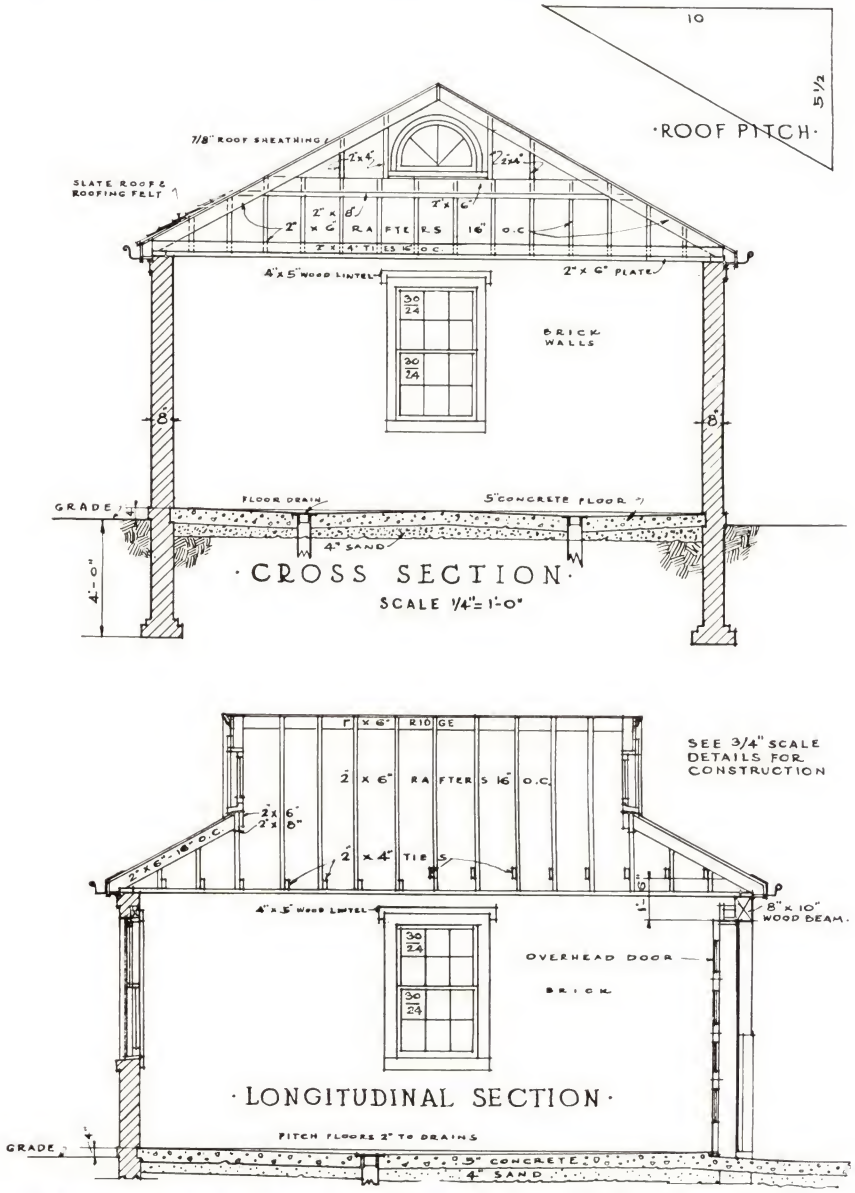
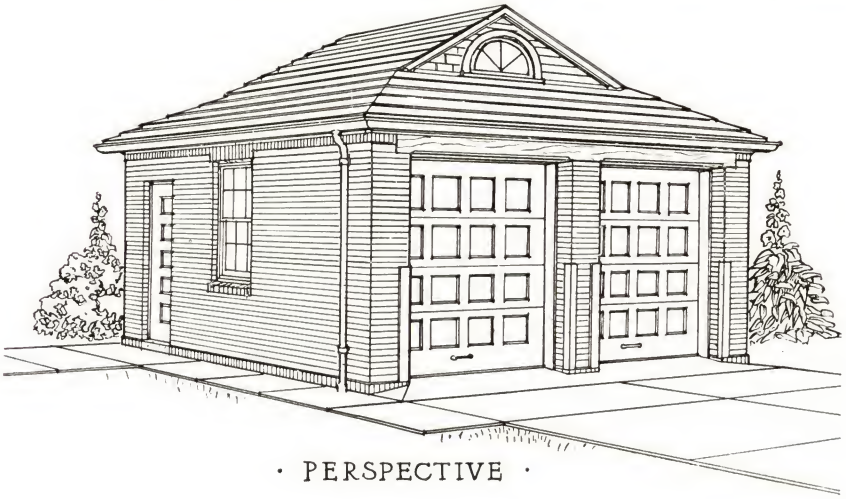


Figure 106.—Cross sections through building showing the method of framing the roof.

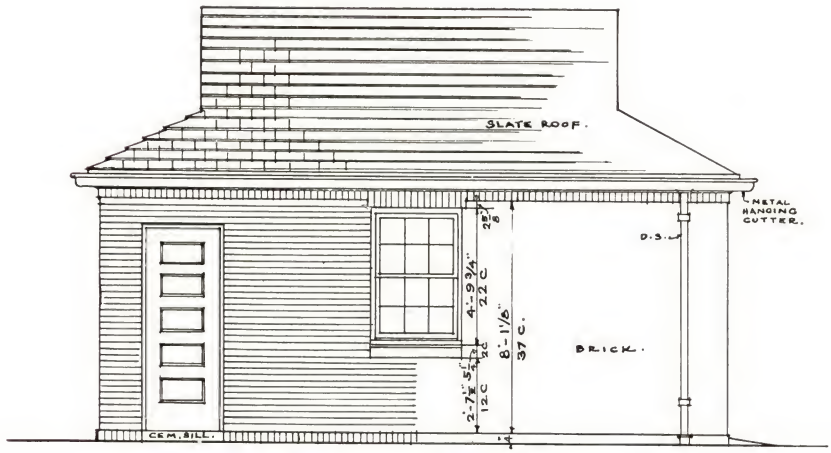
Figure 103 shows enlarged detail sections of various parts of the construction. These include illustrations of backing up the face wall with hollow tile instead of brick. The details show the two types of

lintel supports over the doorways, one of timber and the other of steel. Other details show the proper method of flashing over the sill.

Figure 104 shows an elevation of the left wall construction. It indicates that running bond is used, which is bonded through the wall



· PERSPECTIVE ·



· LEFT SIDE ELEVATION ·
· RIGHT SIDE SIMILAR OMITTING DOOR
SCALE: 1/4"= 1'-0"

Figure 107.—Left side elevation and perspective view of 2-car garage.

by headers at every sixth course. It is not customary on a working drawing to show the bond of the wall, but this illustration is included to indicate how the brick in the wall are spaced between door jamb and window in order to save cutting of the brick.

IV. Details of construction.

1. Bonds and mortar joints.

***a*. Structural bonds.**

***b*. Pattern bonds.**

Preliminary.

The term "bond" when referred to in brickwork has two meanings—structural and pattern. Structural bond refers to the method of over-

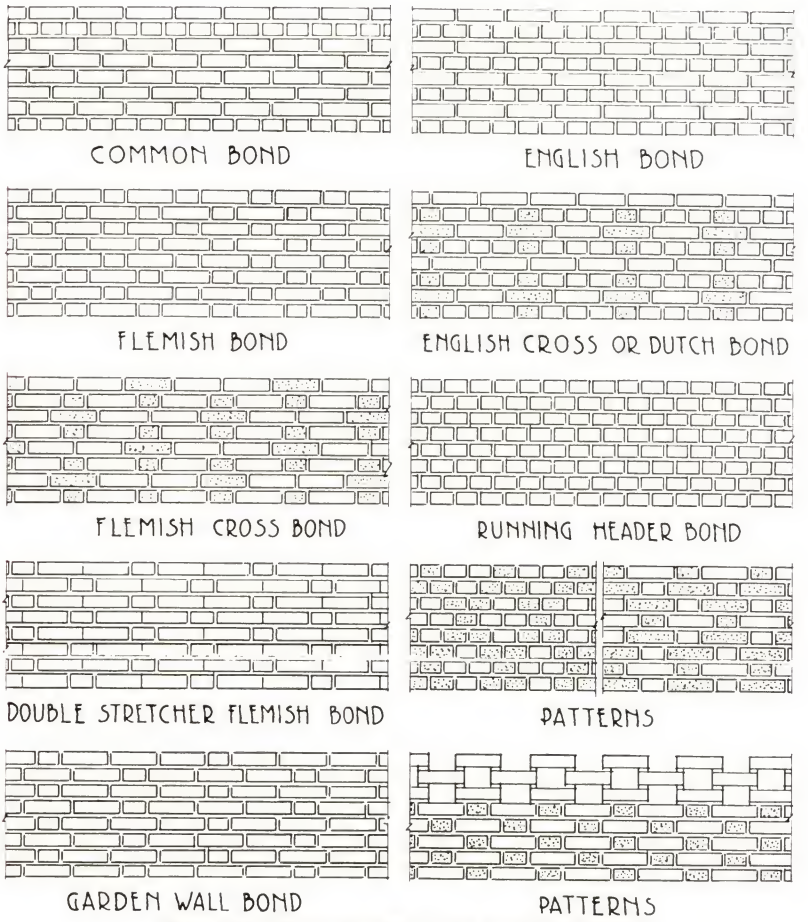


Figure 108.—Various pattern bonds used in brickwork.

lapping brick to give the wall greater strength. Pattern bond has to do with the arrangement of the brick in the face of the wall to give a pleasing appearance.

In some instances the pattern bond is the same as the structural bond. For example, a wall laid up in common bond may have header course every fifth, sixth, or seventh course. These header brick tie the face tier of the wall to the backing and when spaced at

regular course heights give a definite pattern arrangement to the wall. Not all pattern bonds are structural, however. For example, in a number of brick bonds described in this section, the headers in the wall are used only for pattern design and do not add to the structural bonding of the wall.

Figure 108 shows a number of the more generally used bond patterns that have been developed during the time that brick has been in use. Most of these bonds have been used in an effort to improve the appearance of brick walls from the standpoint of design. These pattern bonds relieve the regularity of surface arrangement in large wall areas.

Types of mortar joints.

Mortar in connection with brickwork is used primarily to provide a plastic material to join the brick together into a cohesive structural unit. In addition, the color, width, and character of mortar joints have a great deal to do with the appearance of the brickwork.

Mortar joints vary from ⅛ to ⅞ inches in width. The narrower joint is used with a smooth uniform pressed brick and the extremely wide joint with a rough-textured brick. The standard width of mortar joint for all ordinary brickwork is about ½ inch. The width may be slightly under this dimension when smooth effects must be emphasized and slightly wider—⅝ inch for rough-textured brick.

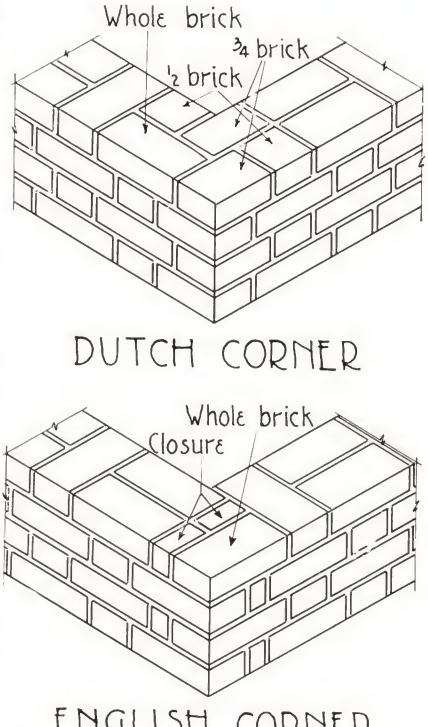


Figure 109.—Corners of 8-inch brick walls laid up in Dutch and English pattern bonds.

The Dutch pattern bond corner illustrated at the top uses a three-quarter brick on the face of alternate courses. The English pattern bond illustrated at the bottom uses a quarter-closure brick on alternate courses.

Brick of standard size, approximately 2¼ inches x 3¾ inches x 8 inches, work out well in combination with mortar joints for all of the pattern bonds when an average width of mortar joint is used. When mortar joints of greater or less width than the average are used in the face of the wall, the backing-up masonry requires considerable cutting in order that the headers may be placed in the proper position.

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Certain of the brick bonds require careful working out at the corners and the return at the jamb in order that the bond, both pattern and structural, may be retained. English bond, Dutch or English cross bond, and garden wall bond, require the use of ¾-length brick at the corners and at the jambs of door and window openings. Flemish bond and double-stretcher Flemish bond require the use of closures or ½-width brick at the corners and sides of jamb. Flemish cross bond requires both ¾-length brick and closures.

Figure 109 illustrates the use of one-half and three-quarter brick at the corner of a wall in which Dutch pattern bond is used. As previously explained, not all of the headers in pattern bond are full headers. Face brick cost more than common brick, therefore, one-half brick are used for headers which do not tie into the backing.

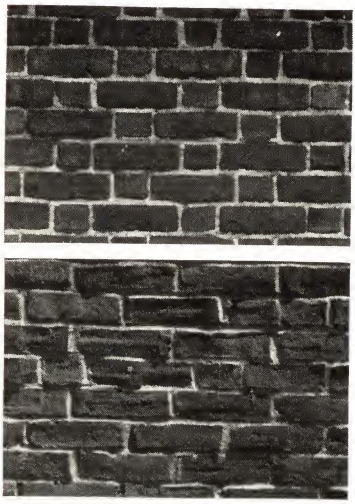


Figure 110.—Detail view of two forms of brickwork.

Panel at top shows a typical example of Flemish bond laid up of common brick with joints of average width. Panel at bottom shows a rough textured brick laid up with wide mortar joints.

For instance, in a wall laid up in English bond every third header course, that is, every sixth course of brick is a full header course, the two intervening header courses being laid up of blind headers or half brick. If half brick are not used, English pattern bond walls would require one-half more face brick and one-half less back-up brick in an 8-inch wall.

Even when common brick are used throughout the wall and no difference in cost is involved, the same method of bonding is followed, thus making every sixth course a full header course. This provides for the same amount of bonding of the face wall to the backing as is provided in a wall laid up in common bond.

Flemish bond with alternate headers and stretchers in every course, and full headers throughout, requires one-third more face brick. When full headers are laid in every third course the cost is reduced since this type of bond requires only one-sixth more face brick. Flemish cross bond should have full headers in the alternate courses, so that the structural bonding of the wall will be equal to a wall laid up in common bond. The bonding of the brick in laying up a wall in common bond is the standard usually required by city building codes. Figure 110 illustrates well laid up walls made of common and Flemish bond.

Running bond is used in brick-veneer walls laid up over wood frame construction and is sometimes used in solid brick walls. The veneering of a frame structure consists of laying up a facing entirely of stretchers as shown in figure 111.

In brick-veneer walls any type of pattern bond may be used, but since the wall is only the thickness of one brick all the headers are blind headers possessing no structural value. The brick veneer wall, regardless of what type of bond pattern is used, is tied to the frame of the building with galvanized iron or steel wall ties nailed through the sheathing into studding in every fourth or sixth course of brick.

In pattern bonds of all types it is the common practice to use over-burned or fire-flashed, that is, dark-colored brick for the headers and also for certain of the stretchers in order to work out the wall pattern. The contrast is clearly shown by the illustrations appearing in this section

Figure 111.—Front entrance detail of brick residence.

An example of running bond built entirely of stretchers, brick on edge being used for second story windowsills.

Finish of mortar joints.

The finish of mortar joints is determined to a large degree by the texture of the brick and the architectural effect it is desired to produce.

The mortar joints in exposed faces of brickwork are finished in various ways. Figure 112 shows a number of mortar joint finishes. The common method of finishing joints on unfinished exterior and rough interior brickwork is to cut the mortar forced out between the brick flush with the face of the wall with the trowel. This produces what is termed a "flush" joint.

On exterior and interior work where the walls are to be plastered, that is, stuccoed, the joints are usually raked out about ⅜ of an inch

in depth to provide a key for the plaster or stucco. These joints are prepared similarly to the raked joints illustrated in figure 112.

The common method of finishing the joints on semifinished exterior work, the brickwork of basements, and other interior walls, is to use what is called by the trade a "struck" joint. The struck joint is made with the point of the trowel, since the bricklayer works over the top of the wall from an inside scaffold. Because of the bricklayer's position on the inside of the wall, the lower edge of the brick course is used as a line to guide the point of the trowel. This causes the lower edge of the mortar joint to be pressed slightly back from the face of the wall, as illustrated in figure 112.

The struck joint is used in about 90 percent of common brickwork. In making this joint, however, care should be taken not to exaggerate the slope of the mortar joint by pushing the point of the trowel too

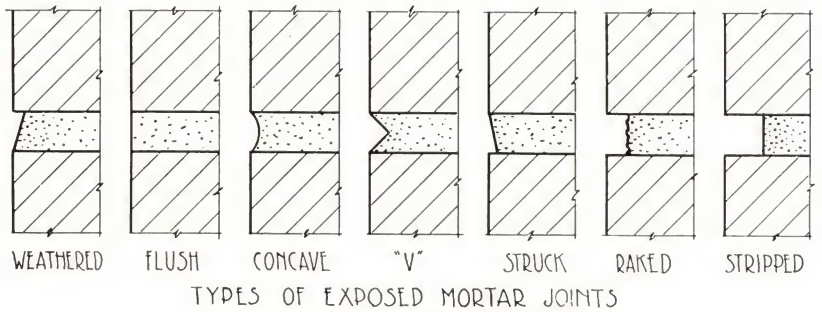


Figure 112.—Types of exposed mortar joints.

far from the face of the wall. It should never be more than ⅛ inch. The best effect is obtained not only from the appearance of the finished work but for the most satisfactory type of weathering results, when the edge of the struck joint is indented about ⅛-inch from the surface of the wall. Figure 112 illustrates the proper slope of struck and weathered mortar joints.

The weathered joint is an excellent type of mortar joint for exterior exposed brick walls but is not generally used because it is impractical to make this joint from an inside scaffold. The bricklayer would have difficulty in reaching over and using the point of his trowel on the top edge of the course. This type of joint can be satisfactorily produced when an outside scaffold is used, hence, the use of this type of joint is limited to walls of moderate height. From an architectural point of view, the weathered and struck joints produce a slightly different effect from flush joints in casting shadows of the courses on the face of the wall. When it is desired to accent the joints or make the bed joints appear more distinct, the mortar joints are either raked out or stripped. In the first case, the mortar is raked out roughly to a

depth of about ¼ inch with a gaging tool. In the case of the stripped joint, the mortar is held back when the bed is made by placing ½ inch x ½ inch square bars of wood or iron of various lengths on the mortar bed even with the face of the wall. After the brick have been laid and the mortar sufficiently set, the strip is removed, cleaned off, and used over and over again. These strips vary in length from 7 inches to 3 feet or more.

With the stripped type of mortar joint it is necessary to rake out the vertical joints with a tool after the strips in the bed joints have been removed. It is not advisable to use these two types of mortar joints in sections of the country where beating rains or melting snow or ice are likely to remain on the surfaces of the wall.

Figure 113.—Recessed entrance, having jambs and arched soffit of brick laid up in patterned bonds of varied designs, separated by plain headers.

Tooled joints may be either concave or convex. The convex or beaded mortar joint is seldom used in modern work but the concave type of joint is a most excellent one for finishing brickwork. In making this joint the mortar is first cut off and pointed flush, and after the mortar has taken its initial set, it is pressed back into the joint with a concave tool. This forcing of the mortar into the joint brings the brick surfaces in close contact with the mortar thus making the joint not only smooth but more weathertight than some other types of joints.

The "V" type of mortar joint, illustrated in figure 112, is seldom used except for architectural effects. In making this joint, the mortar is cut and pointed flush the same as for concave mortar joint and when the mortar has partially set the recessed "V" is produced by running the smooth edge of a planed board over the joint. If the end joints are to match the bed joints, it is necessary to point these with a pointing trowel.

For rough textured face brickwork laid up with unusually wide joints, sometimes nearly ¾ inch in thickness, a stiff mortar is used which con-

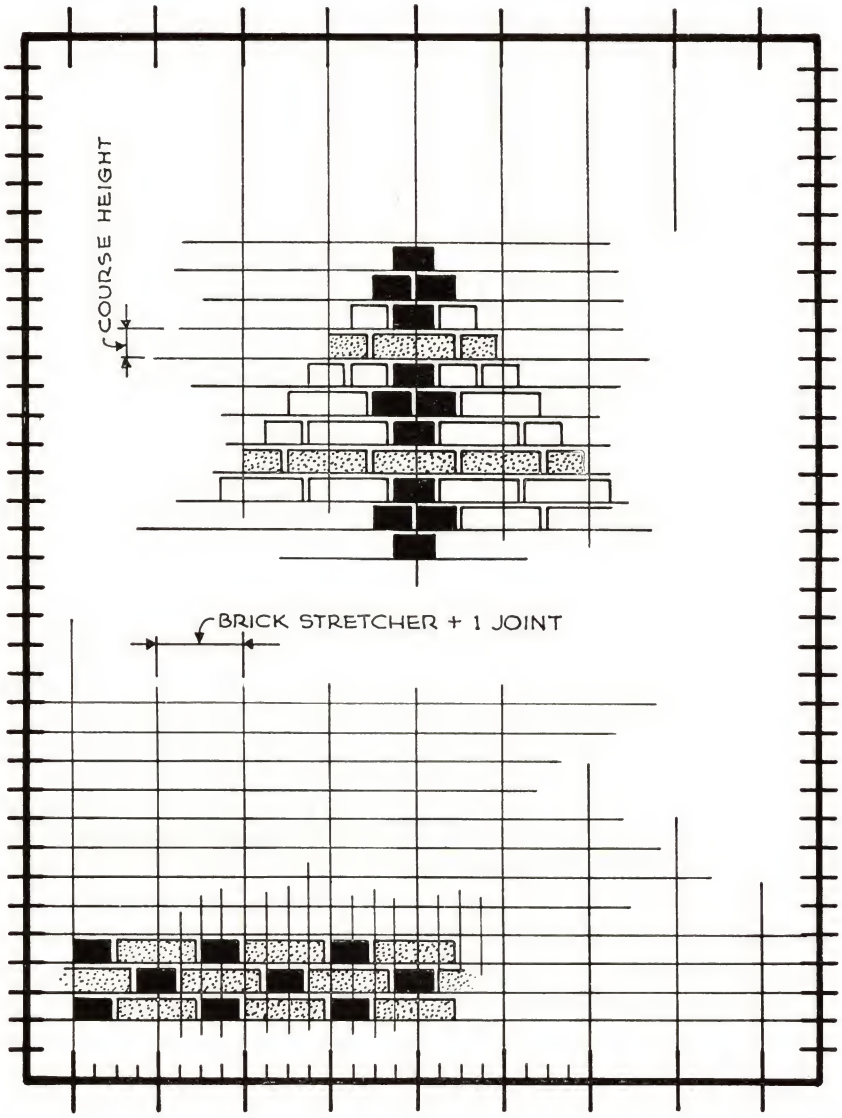


Figure 114.—Method of laying out brick pattern bonds on cross-section paper.

Upper part of drawing shows a diagonal pattern bond. Lower section of drawing shows a Flemish bond pattern with flashed headers.

tains a gravel aggregate. Such joints are invariably finished by cutting the mortar flush with the face of the wall.

Brick patterns.

Brick of standard size when laid up in most of the pattern bonds overlap each other at least one-quarter of the length of the brick in each succeeding course. This overlapping repeats itself in mathematical exactness throughout the length of the wall.

For this reason it is easy for the bricklayer to lay out the courses in the wall, both horizontal and vertical, if the bond pattern has been decided upon and the width of mortar joints determined.

To assist the bricklayer and particularly the apprentice in laying out pattern designs, a diagram or drawing of the brick units in the wall surface may be made. The manufacturers of brick have printed cross-section paper which is ruled with spaces equal in length to a stretcher and mortar joint. This sectional paper is laid out in such a way that the distance has been reduced to approximately one-sixteenth of the actual dimension. This length is also divided into four equal parts, so that the overlapping of the brick in the various courses may be properly located. The course heights are laid out by using the depth or thickness of a brick and the width of a mortar joint.

Figure 114 shows a drawing on which the stretchers and course heights of brick are indicated by definite units of measurement. A diagonal pattern design in the upper part of the diagram is laid out from a center line so the bond pattern is symmetrical on each side of the center. Figures 18, 52, and 113 show examples of well laid-out brick patterns.

In addition to laying out the pattern bond on paper, the bricklayer should compute the length of courses in feet and inches and the total height of various pattern bonds with varying widths of mortar joints in feet and inches.

This distance can be determined in a wall laid up in running bond by multiplying the unit length of a brick and mortar joint by the number of brick in the course. In other types of bonds such as Flemish, where the courses are made up of stretcher and header, the problem is not quite so simple. Tables, scales, and bricklayer's rules have been devised to assist the bricklayer in determining the number of brick in a course of a certain length and the number of courses in a definite height.

Table III is an example of a table of course lengths which can be prepared by an instructor or apprentice bricklayer.

A similar table may be prepared for the alternate Flemish bond courses which start with a ¾-length brick instead of a ½ brick. These two tables when completed for certain wall lengths will give the number of whole and ¼-length brick in a wall laid up in Flemish bond. Other tables may be prepared giving course heights of walls laid up with various thicknesses of mortar joints.

Table III.—Total length of course laid up in Flemish bond with ½-inch mortar joint

Brick and ½-inch mortar joint:	*Length in feet and inches*
½ brick	0′–4¼″
1½	1′–0¾″
2	1′–5″
3	2′–1½″
½	2′–5¾″
4½	3′–2¼″
5	3′–6½″
10½	7′–5¼″
15	10′–7½″
20	14′–2″

In this table the length in feet and inches in units made up of brick and ½-inch mortar joints is given. It will be noted that the brick course which is included in this table starts with ½ brick and is followed with a stretcher. The table is not complete since there are omissions between the 5 and 10½ brick, 30 and 40½ brick, and 50 and 60 brick and mortar joints.

Since the bricklayer lays out his wall in units made up of 4 courses of brick and 4 mortar joints, the more common group of course heights should be used, such as 10½ inches, 11 inches, 11¼ inches, 11½ inches, 11¾ inches, and 12 inches. These represent respectively 2⅝-inch, 2¾-inch, 2$^{13}/_{16}$-inch, 2⅞-inch, 2$^{15}/_{16}$-inch, and 3-inch course heights.

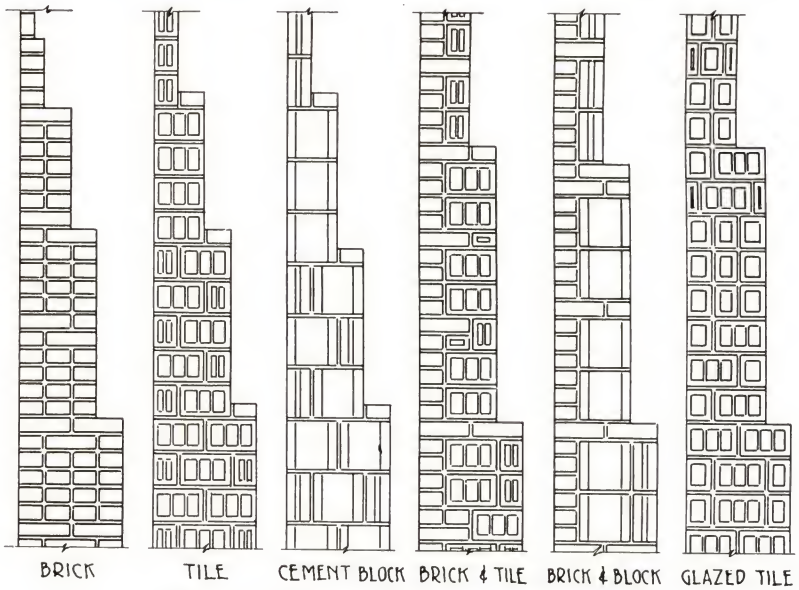


Figure 115.—Structural bonding of masonry walls.

Structural bonding of walls.

The method of bonding the outer wall with the backing varies with the several bonds used in brick masonry. Figure 115 shows the method of bonding walls laid up with 2, 3, and more courses of brick. It also illustrates the method of bonding other masonry materials such as structural tile and cinder and cement blocks. The drawing also shows the bonding of glazed brick to brick backing.

Figure 116 illustrates an 8-inch and a 12-inch wall laid up in common bond in which the 8-inch wall is backed with brick and the 12-inch

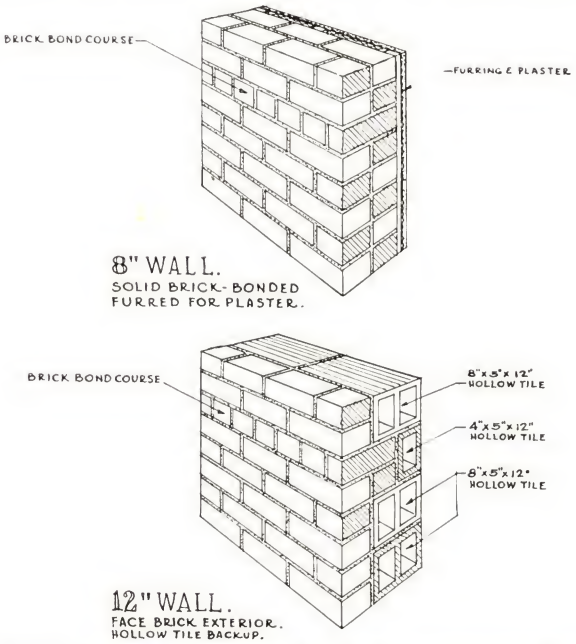


Figure 116.—An 8-inch and a 12-inch brick wall backed up with brick and hollow tile.

wall with hollow tile. The illustration shows the bonding of the backing to the face of the wall.

III. Materials of the trade.

4. Architectural terra cotta.

***a*. Uses.**

Preliminary.

Architectural terra cotta is a masonry building material first used by the Greeks and Tuscans in the construction of their temples and monumental buildings. It was used extensively by these early builders because it could be easily molded and shaped into desired forms, glazed in a variety of colors, and fired, thus producing a permanent ceramic building product. It was used for interior and exterior walls of buildings, and as decorative architectural features such as cornices, columns, and pilasters, and free-standing sculptured ornaments.

Modern uses.

The method of manufacturing and the process of setting architectural terra cotta have changed somewhat in recent years. The common method of manufacturing has been to make a model of the shape or shapes to be used and to cast molds from these models. A plastic mixture of clay and grout is forced into these molds by hand. Webbings are molded in the back of the pieces of terra cotta into which the brick or anchors used for fastening the terra cotta facings to the wall are placed when the pieces are finally set in the wall.

Rothschild Photo.

Figure 117.—A branch post office building faced with architectural terra cotta, New York City. Supervising Architect's Office, United States Department of the Treasury, architects.

An example of the use of light-colored plain architectural terra cotta ashlar blocks in exterior walls. The base, cornice, and entrance features are in contrasting colored glazes.

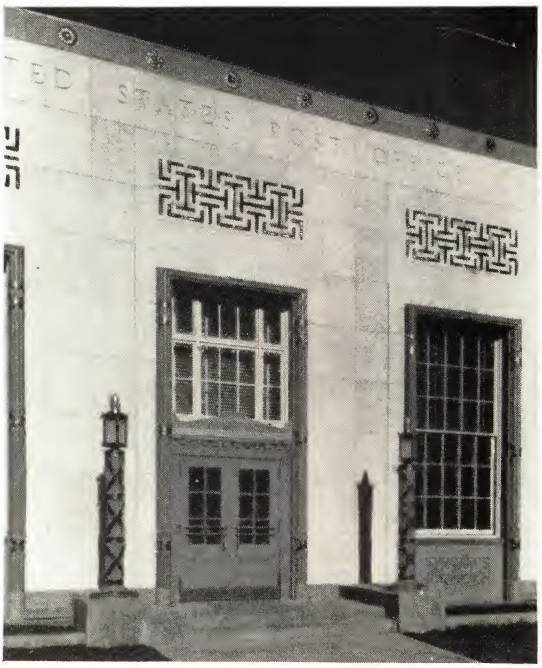
The clay shapes are then removed from the molds, dried, and later sprayed with glaze of the desired color, after which the material is burned in kilns in a fairly high degree of temperature. The process of firing is similar to that used in producing brick or other clay products. In the past, terra cotta facings or shapes have been limited in size because of the natural warping of the material when fired. For certain effects these natural irregularities give character and distinction to a finished job.

In recent years, however, the terra cotta manufacturers have developed an extruding process which makes it possible to mold the pieces of terra cotta in the form of a slab with a solid back. To further overcome the slight variation in molding and to give the blocks a straight face, the dried shapes are planed on the surface before firing. After firing, the edges are ground to exact dimensions. The planing of the surface and the grinding of the edges produces a rather large perfectly-shaped slab of uniform color. These pieces of terra cotta are set in place by the bricklayer who anchors them in the same manner as cut-stone facing is anchored to the backing wall.

In recent years the machine-extruded material has become an extensive product of the terra cotta industry. An example of the change in exterior design of buildings and the method of construction in which plain surfaces and larger units are used is shown in figure 117. In the post office building illustrated the ashlar-shaped terra cotta blocks are approximately 24 inches wide by 33 inches high.

Figure 118 shows another example of the use of terra cotta ashlar shapes in a Government building. It will be noted that the plain wall surface has been relieved by an open fret design above the window and entrance openings. The cornices in some of the terra cotta faced buildings are molded and fired in one piece approximately 4 feet long.

An example of the



Baker Photo.

Figure 118.—United States Post Office Building, Ridgewood, N. J. Supervising Architect's Office, United States Department of the Treasury.

Light colored architectural terra cotta ashlar blocks, laid up with stack jointing, are used for facing the exterior walls of this building. The trim around the openings, the cornice coping and lamp standards are of a darker glazed architectural terra cotta.

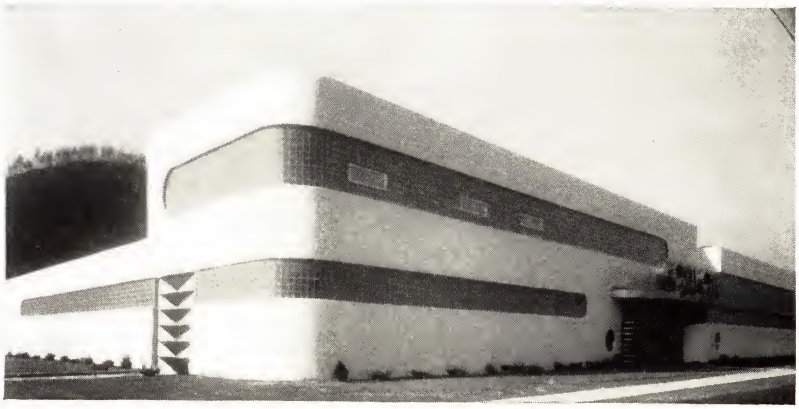


Figure 119.—A modern bakery laid up of architectural terra cotta and glass blocks. McCormack Co., architects.

use of terra cotta in combination with other building materials such as molded glass is shown in figures 119 and 120. The structure shown in figure 119 is an industrial building in which the veneered facing of terra cotta and the large area of molded glass is placed in front of the structural steel framework which supports the floors and roof and to which the walls are anchored. The size of these blocks is approximately 12 x 24 inches.

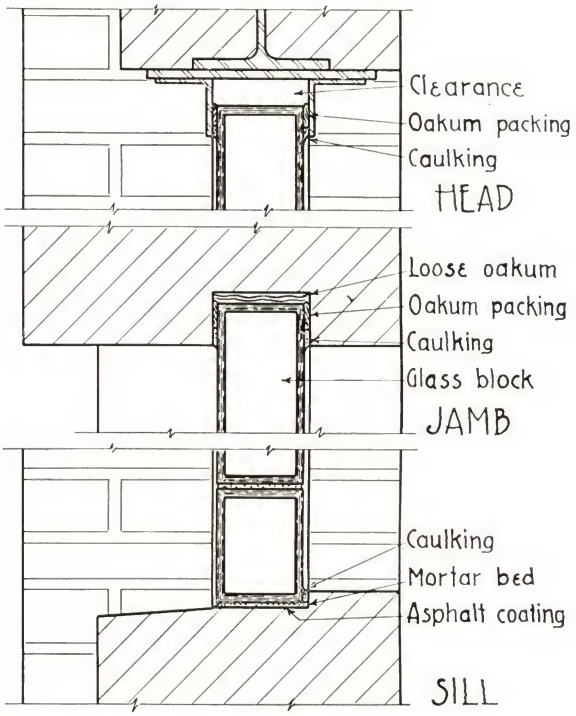


Figure 120.—Crosssection view showing method of setting glass blocks in a masonry wall.

III. Materials of the trade.

7. Tools and equipment.

***c*. Tools of the bricklayer.**

Preliminary.

The bricklayer does not need a large number of individual tools in his kit. However, those which he does use should be made of good material and adapted to his individual needs. Although the bricklayer can get along with few tools, he should have the following: Bricklayer's trowel in several sizes, a pointing trowel, a level, a bricklayer's hammer, a chisel, and a mason's square. In doing all ordinary types of work the bricklayer should have a chalk line and a device for fastening the line to the wall, and jointer tools. For particular types

of work he should have other tools such as a bricklayer's scutche used in setting firebrick; a raking tool used to produce certain types of joints; a mason's folding rule; and a steel or reinforced measuring tape.

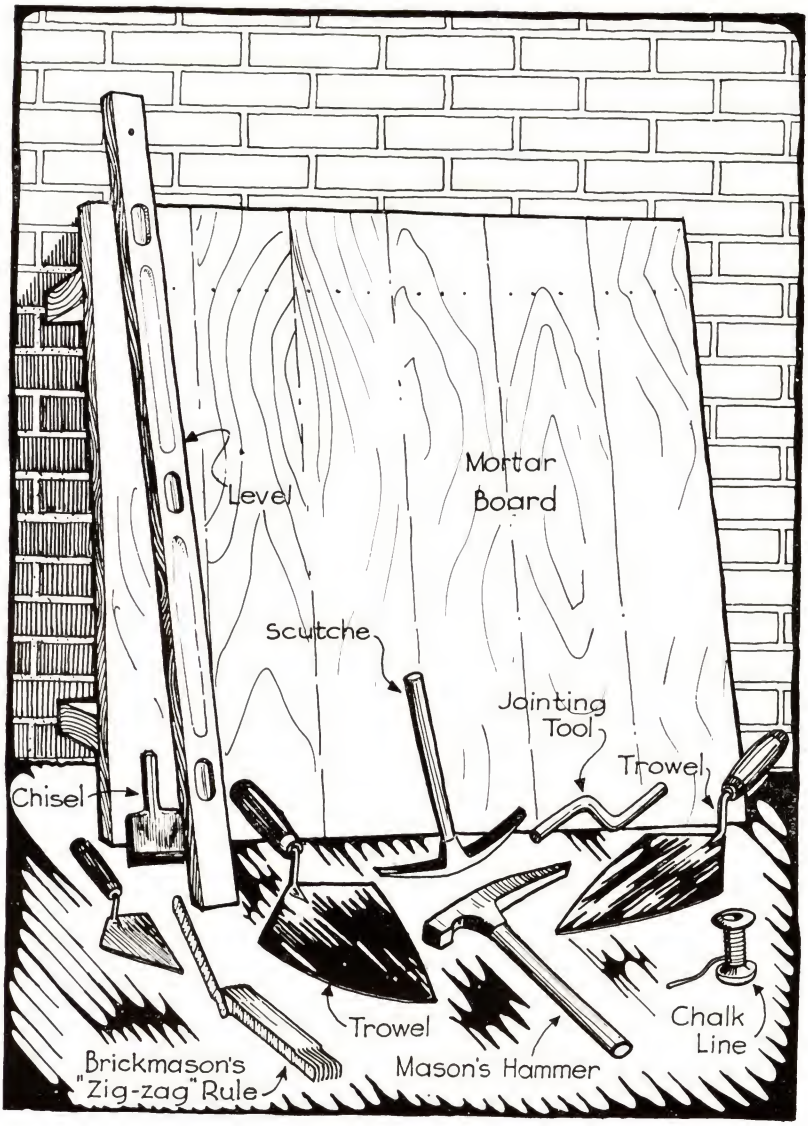


Figure 121.—Some of the tools used by the bricklayer.

Trowels.

Brick masons' trowels vary in length from 9½ inches to 12 inches. The length of the average trowel is 10 inches or 10½ inches. There are several different models of trowels made to fit individual needs. The blades of the trowel vary in width and length. The handles and

the method of placing the handles on the blade vary with the different models in common use. In all instances the trowels are made of special steel carefully tempered and ground to meet the needs of the trade.

Other tools.

Plumb rules or levels are usually made of wood or metal and are 3½ feet to 4 feet in length. For close work a level of shorter length is required. These short levels are from 12 inches to 24 inches in length. All levels are fitted with vials so that they may be used for both plumbing and leveling purposes.

Other equipment for the bricklayer which is furnished by the mason contractor includes mortar boards or tubs, scaffolds and ladders, and heavy equipment. In some parts of the country mortar boards are used in preference to tubs. The square tub is made of sheet steel with tapered sides and varies in size from 28 to 36 inches square, and in depth from 8 to 10 inches. The advantage of a tub for cement mortar is obvious since cement mortar is usually thinner than other mortar and it is necessary to mix it frequently so that it may have the proper consistency. A tub may be used to advantage in laying brick by the pick and dip method. Another advantage of a metal tub over a mortar board is that the tub is easier to handle on the scaffold and can be stacked away in a small space with other equipment when not in use.

Brickmasons, like other craftsmen, have their individual preferences and want tools which meet their particular needs. See figure 121. The manufacturers of mechanics' tools are aware of the requirements of the trade and make tools and equipment to meet the specifications of the skilled worker.

IV. Details of construction.

6. Special constructions.

***a*. Chimneys and stacks.**

Preliminary.

Masonry chimneys for individual plants and large domestic heating boilers, when constructed free standing, are usually circular in plan and laid up with special-shaped brick. They are designed in a circular shape rather than square or rectangular, because gases flow with less friction from the sides of circular stacks.

Chimneys are used not only for carrying off gases and smoke from heating boilers, but in connection with kilns, oil and gasoline stills, glass ovens, retorts, and annealing and melting furnaces.

Radial brick.

Round chimneys are usually constructed with brick which are molded with a slight curvature on the inside and outside faces. These brick are made of the same material as any other brick, that is, of clay, shale, or fire clay. They are usually molded with cells similar

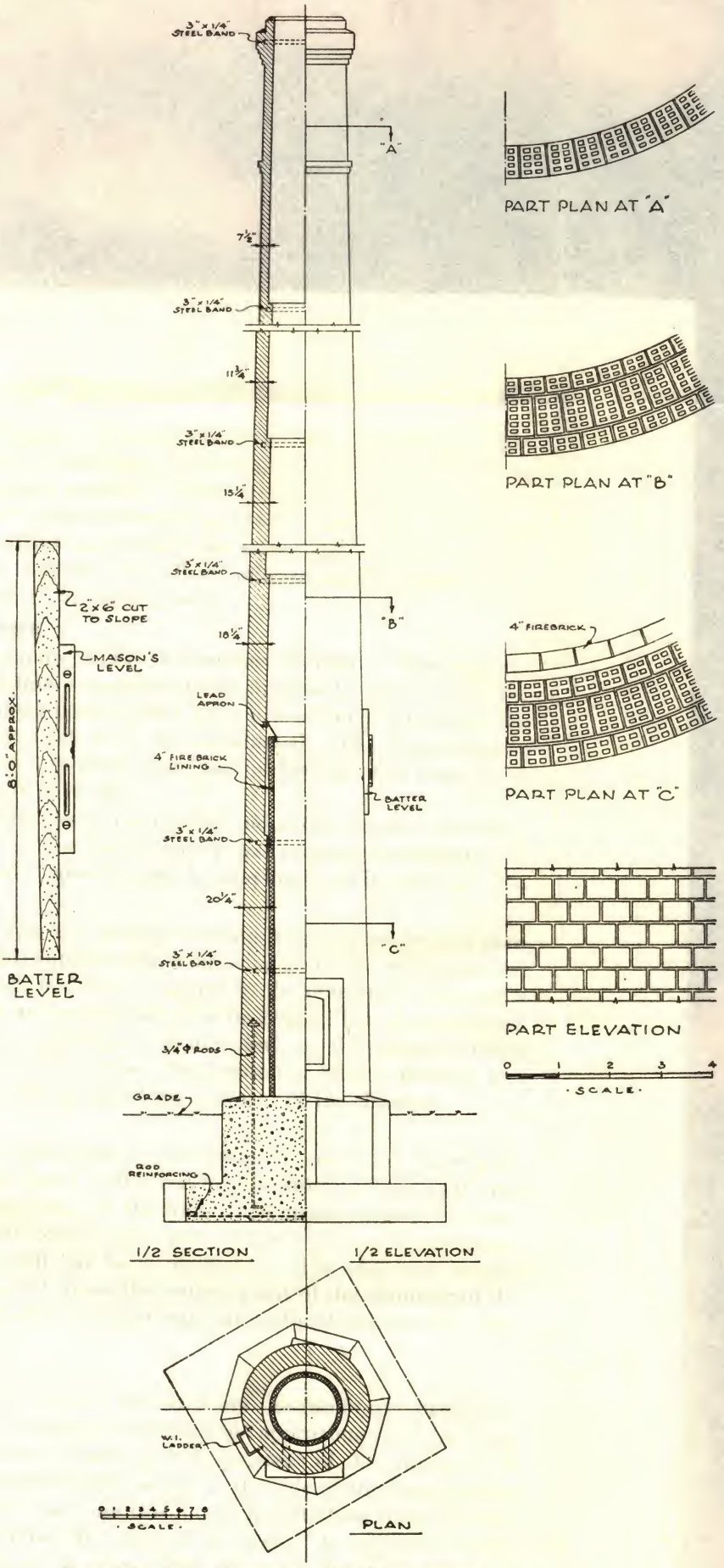


Figure 122.—Setting drawing of a radial brick chimney.

The elevation and section shows the method of constructing a radial block chimney.

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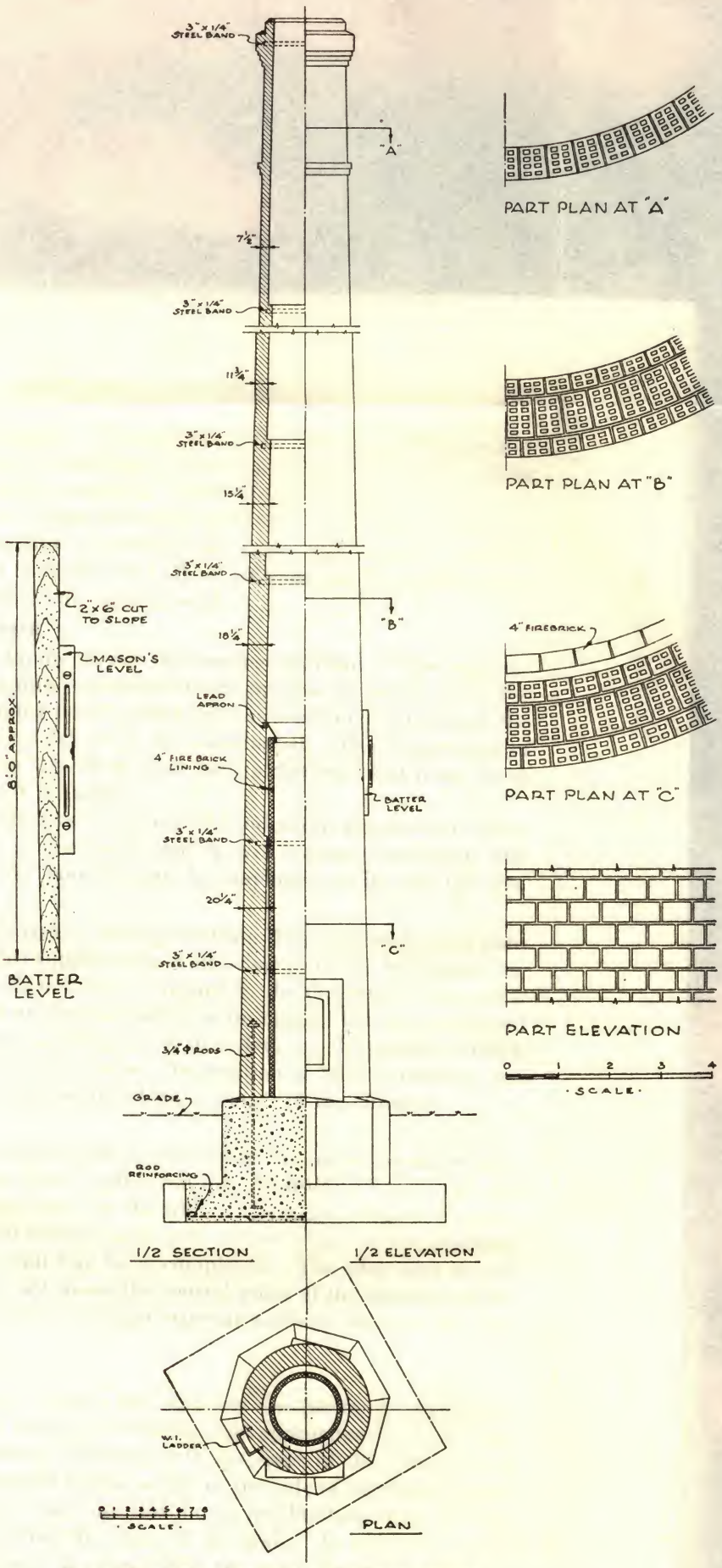

Figure 122.—Setting drawing of a radial brick chimney.

The elevation and section shows the method of constructing a radial block chimney.

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DETAILS OF BRICK STACK

in design to glazed brick. The purpose of the cells or perforations is to relieve the dead load of the mass of brick in the wall and also to allow for proper firing of the material. These brick vary from 4 or 5 to 9 inches, and even 12 inches in length and from 5 to 8 inches in width. The heights of the brick are usually the same, that is about 4 inches. The adjustment of the brick for walls of different radii is usually taken care of in the width of the mortar joint.

Size and height of stack.

Designing a chimney is an engineering problem. The engineer must not only take into consideration the purpose for which the stack is to be used, but must bear in mind also the location or altitude of the plant in which the stack is to be constructed. The dimensions of chimneys vary from 7 to 20 or more feet in diameter and from 50 to several hundred feet in height.

Even though chimneys to be used for industrial purposes are carefully designed, it is necessary that a well-trained bricklayer who understands chimney construction be employed to lay up the job.

Setting drawings.

The engineer prepares a setting drawing from the architect's plan and elevation. This supplementary drawing gives the bricklayer the information he needs not only in regard to the diameter of the stack at the bottom and at various points in its height, but also in regard to the type of lining, the height it is to be laid up, the points at which reinforcing rods are to be placed, the location of breech opening, and other information, such as the slope or batter of the chimney.

Radius rod.

In laying out a round stack it is necessary to know the center location of the stack so that a radius rod may be used to "mark off" the external and internal faces of the wall. The usual practice is to lay up the lining, which extends only part of the height of the chimney, after the external wall has been completed. The plan and section illustrated in figure 122 shows the central point of the diameter of the chimney and the thickness of the external wall and lining at the base of the chimney

Batter board.

Since the chimney is to be laid up from the inside, the bricklayer uses a batter board which is a straight edge approximately 8 feet long with one side tapered to conform with the slope of the chimney. A mason's level is fastened permanently to the side of the batter board so that the bricklayer may use this device in plumbing from the outside and thus determine the slope of the wall. As indicated in the section drawing shown in figure 122 the wall thickness varies at different heights and reinforcing rods are placed in the wall at regular intervals.

Bonding the wall.

It is very necessary that each unit making up the shell of the wall be bonded together. Most chimneys are lined at the bottom with fire clay brick which is placed at least 2 inches from the inside of the outer wall and laid up in a vertical manner to a height which usually ends at the first reduction in thickness of the outer wall shell. A stack started with a wall thickness of 18½ inches may be made up of three radial brick. Cross section "c" shown in figure 122 illustrates the method of bonding the inner and outer walls together. In the chimney here shown the course preceding and following would be laid up with brick 9 inches in length so the overlapping would thoroughly bond the wall together.

When the construction of a chimney reaches a certain point it is necessary to insert reinforcing bands which must be completely covered and inserted within the joint. These reinforcing bands are usually placed in the wall when a change in thickness occurs. Reinforcement bands are also placed below and above the flue opening and in the corbeling at the top of the chimney.

Circular storage bins.

Circular bins for the storage of dry and wet materials are laid up with glazed brick or tile. In agricultural sections of the country round storage tanks called silos are used for the storage and preservation of ensilage. These round tanks, varying in diameter from 10 to 20 feet, are laid up of walls of brick or specially-shaped curved tile units. When tile blocks or brick are used in the construction of storage tanks, steel reinforcement rods are embedded in the mortar joints between every course or alternate courses.

It is the usual practice to place rods in every mortar bed near the bottom of the circular tank. Table IV shows the capacity of storage bins of various diameters for different types of materials including sand, coal, lime, and grain. In order that these round tanks may be entirely fireproof, brick or tile tops are laid over special forms so as to provide a fireproof and waterproof roof.

These circular storage bins have to be designed to meet various conditions such as pressure from within and to withstand wind pressure from without. Brick and tile units are made in a variety of shapes to conform with various diameters.

Table IV.—Capacities (in cubic feet, cubic inches, bushels, gallons, or tons) of storage bins of various diameters—per foot of height

Materials	Diameter in feet							
	10 feet	12 feet	14 feet	16 feet	18 feet	20 feet	22 feet	24 feet
Cubical contents—cubic feet	78. 54	113. 10	153. 94	201. 06	254. 47	314. 16	380. 13	452. 39
Sand or crushed stone—cubic yards	2. 91	4. 18	5. 70	7. 44	9. 42	11. 63	14. 08	16. 75
Crushed stone or sand (100 lbs. per cu. ft.) tons	3. 93	5. 65	7. 70	10. 05	12. 72	15. 71	19. 01	22. 62
Coal—anthracite (52 lbs. per cu. ft.)—tons	2. 04	2. 94	4. 00	5. 23	6. 62	8. 17	9. 88	11. 76
Coal—bituminous (50 lbs. per cu. ft.)—tons	1. 96	2. 82	3. 85	5. 02	6. 36	7. 85	9. 50	11. 31
Cinders (45 lbs. per cu. ft.)—tons	1. 77	2. 54	3. 46	4. 52	5. 72	7. 07	8. 55	10. 18
Salt (48 lbs. per cu. ft.)—tons	1. 88	2. 71	3. 69	4. 82	6. 11	7. 54	9. 12	10. 86
Lime—unslaked (53 lbs. per cu. ft.)—tons	2. 08	3. 00	4. 08	5. 33	6. 74	8. 32	10. 07	11. 99
Lime—hydrated (40 lbs. per cu. ft.)—tons	1. 57	2. 62	3. 08	4. 02	5. 09	6. 28	7. 60	9. 05
Cement in bulk (94 lbs. per cu. ft.)—tons	3. 69	5. 32	7. 23	9. 45	11. 96	14. 76	17. 87	21. 26
Grain (1 bu. = 1.244 cu. ft.)—bushels	63. 11	90. 88	123. 70	161. 56	204. 48	252. 45	305. 46	363. 52
Liquid (1 gal. = 231 cu. in.)—gallons	587. 52	846. 05	1, 151. 55	1, 504. 03	1, 903. 57	2, 350. 08	2, 843. 57	3, 384. 11

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IV. Details of construction.
6. Special constructions.
***b.* Doorways.**

Special attention is usually given by the architect and builder to the treatment of entrance doorways in plain types of brick buildings. What might otherwise be a plain or commonplace type of structure is completely changed by a well-designed and properly laid up brick doorway. Entrance doors and windows framed with molded or gaged brick or brick of a darker color, give an added touch to a brick structure which otherwise might be monotonous and uninteresting in appearance.

Figure 123.—Old colonial doorway, south entrance, Vauter's church, Essex County, Va.

This doorway is laid up in molded smooth-faced brick with narrow mortar joints. The wall is laid up in Flemish bond pattern using larger size brick. The flashed headers are quite noticeable in the brickwork.

The early builders understood this point and examples of remaining early brickwork show how successfully they designed and laid up entrance doorways.

Only a few examples of early brick doorways remain. Some of these doorways are found in residences but a majority of them are entrances to public buildings and churches in Virginia, Delaware, and Maryland.

Materials used.

Examination of the brickwork of early colonial buildings shows that the walls were laid up of hand-made molded brick slightly larger in size than present-day standard brick. The walls were usually plain, laid up without recesses or projections, and the color was produced by flashed or glazed headers in the Flemish and English bond patterns usually used for this type of brickwork. The jambs and lintels of windows and doors were laid up of hand-molded and darker-colored rubbed or gaged brick. In some instances cut stone was used for keystones, sills, and occasional band courses. Molded brick was

used extensively at the top of the foundation or between the first and second stories.

The remains of early colonial brickwork are shown in figure 126. Both of these rather elaborate doorways are laid up with molded and gaged brick. The design of the pilasters with their base, fluted column, and cap, and the pediments, follow closely the proportions of classical orders of architecture. It will be noted, also, that the jambs of the windows are laid up of a darker-colored brick.

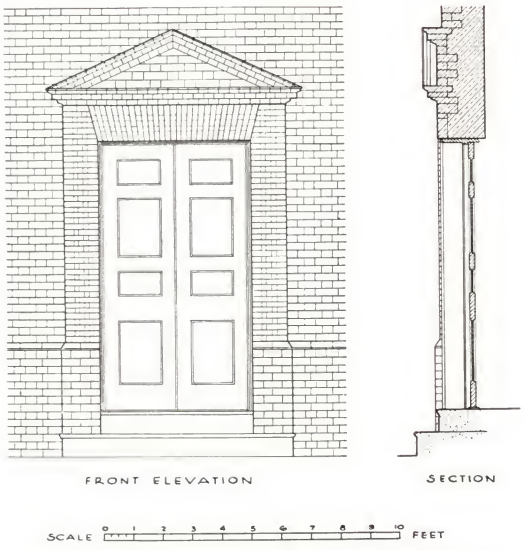


Figure 124.—A line drawing of molded brick doorway.

This illustration shows the front elevation and a cross section of the smaller brick and narrow mortar joints in the trim of the doorway. The section shows the method of bonding the molded shapes into the wall.

Figure 125.—Brick garden wall at Williamsburg, Va., in which a combination of English and Flemish bonds have been used.

Molded brick are used in the base and cap of wall.

Figure 126.—Examples of early colonial molded brickwork.

These photographs show the remains of two well-designed brick entrances in an early colonial brick building. The walls are laid up of sand-molded brick in Flemish bond pattern. It is interesting to note the treatment of window trim in which the jambs and jack arch are laid up with hand-rubbed brick.

This darker color is produced by rubbing off the surface of the brick after they have been fired.

Setting drawings.

The method used today in laying up brick entrances is somewhat different from that followed in colonial times. In most instances, the brick, instead of being cut on the job, are cut, ground, and fitted at the plant and sent to the job with explicit directions for laying up the material in the wall. Figure 124 shows a measured drawing of the old entrance doorway illustrated in figure 123, including the front elevation and cross section. It shows the method of laying up the jambs, the type of jack arch used, and the bonding of the molded brick of the pediment into the wall. Doorways of this type and those more elaborate in design are laid up in practically the same way as they were by early colonial bricklayers.

IV. Details of construction

6. Special constructions.

***j*. Walls and garden ornaments.**

***k*. Columns.**

Decorative brickwork calls for shapes molded in the outline of simple moldings. These molded shapes are used for base and band courses, columns, caps, cornices, and copings. Many brick manufacturers carry a line of special molded shapes which are made of the

Figure 127.—Spacing molded brick shapes.

These molded shapes are laid out "dry" to conform with the outline of the actual construction.

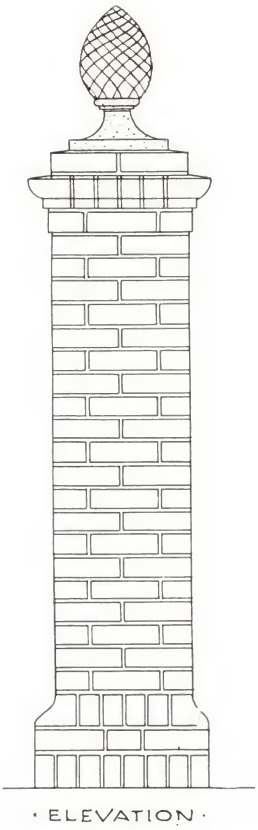
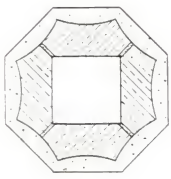


Figure 128.—Molded brick shapes used in base and cap of ornamental gate post.



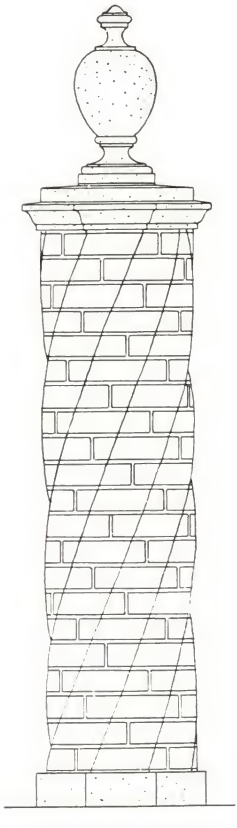


Figure 129.—Molded brick shapes used in shaft base and cap of ornamental gate post.

same material as the extruded and sand-molded stock brick. The color of these special-shaped brick, therefore, blend in with the regular wall surfaces in any type of brick construction.

Figure 130.—Laying out molded brick shapes.

The edges of these brick have been ground to provide for uniform mortar joints when brick are placed on circular wall.

These molded brick are usually made to dimension so that they may be bonded into the wall with standard brick sizes. However, brick intended for some purposes, as for cornices and copings, may be made somewhat larger than standard brick.

Methods of manufacturing.

Since there is a limited demand for special brick shapes, they are usually made by hand and in some instances the edges are ground and fitted before they leave the plant. Figures 127 and 130 illustrate the laying out of molded shapes in a brick plant with spaces between the brick filled in with thin boards the thickness of a mortar joint. These shapes are ground to fit a particular job and are carefully packed and shipped to the job so the bricklayer will not have to cut or rub the brick before laying it in place. Figure 125 shows special molded shapes in place as a coping for a garden wall.

Figure 131 shows coping brick laid on a circular wall which ends in a ramp at the gate post. In fitting molded shapes to a wall of this type it is necessary

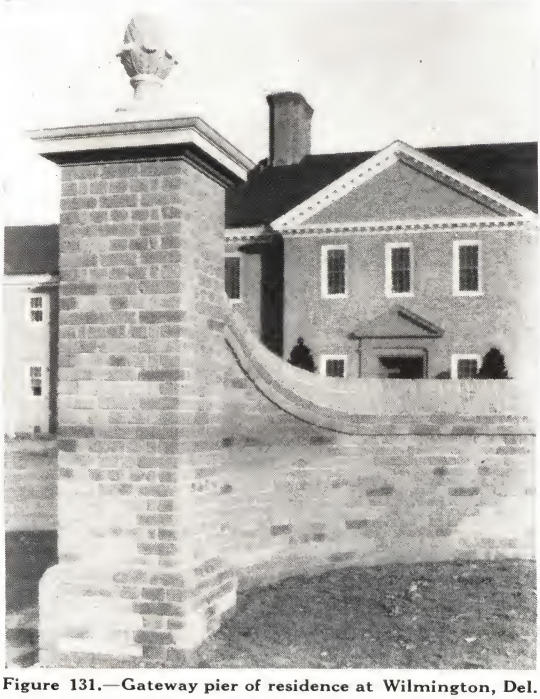


Figure 131.—Gateway pier of residence at Wilmington, Del.

The wall and pier is laid up of hand-made brick in Flemish bond pattern with the mortar joints receded slightly. Half-width brick closures are used next to corners in working out the bond.

to take into account the fact that the wall is circular in plan as well as in elevation.

Molded shapes are used extensively for the base, cap, and shaft of gate posts. Figures 128 and 129 show two gate posts laid up with molded brick. The one at the left has a molded base and cap and the one at the right has, in addition to the base and cap, a molded brick shaft.

Figure 135 shows a bricklayer laying up special spirally-molded brick which is illustrated in elevation drawing, figure 129.

Molded brick are used extensively for columns and shafts.

Figure 132 illustrates the use of molded shapes in an octaganal column.

Figure 132.—Interior view of loggia illustrated in figure 133.

This illustration shows the manner in which the bond of the brick is maintained throughout on the four faces of the piers of the octagonal-shaped columns.

Figure 133.—Wing of dormitory group at Yale Divinity School, New Haven, Conn. Delano and Aldrich, architects.

In this group of buildings there is an interesting contrast between the white-painted architrave, cornice, and window frames and the dark-colored, rough-textured brickwork.

Figure 134.—Facade of gable-end of group of dormitory buildings at Yale Divinity School, New Haven, Conn. Delano and Aldrich, architects.

This building illustrates the use of molded brick for base, cap, and shaft of circular classical type brick column.

Figure 134 shows an outside view of the columns illustrated in figure 141. Molded circular-faced brick have been used in the columns in figure 134.

In addition to the circular molded headers, the base and caps are laid up with molded shapes.

Figure 132 is a close-up view of the base and shaft of columns shown in figure 133 and indicates the care the bricklayer has taken in laying up his courses in order to secure uniform mortar joints.

IV. Details of Construction.

6. Special constructions.

***1.* Paving.**

Both common and specially-made paving brick are used extensively for walks, garden steps and for the paving of porches, terraces, and to a certain extent for floors of basement rooms. Because of their small size, brick can be arranged in a number of interesting decorative patterns and can also be placed to conform with curves and slopes that occur in the construction of walks, terraces, and driveways. The round cornered vitrified paving brick, which are larger in size than common brick, are used for driveways, panels, and borders in sidewalks and terraces. These paving brick on blocks are also used for walks and driveways around important public

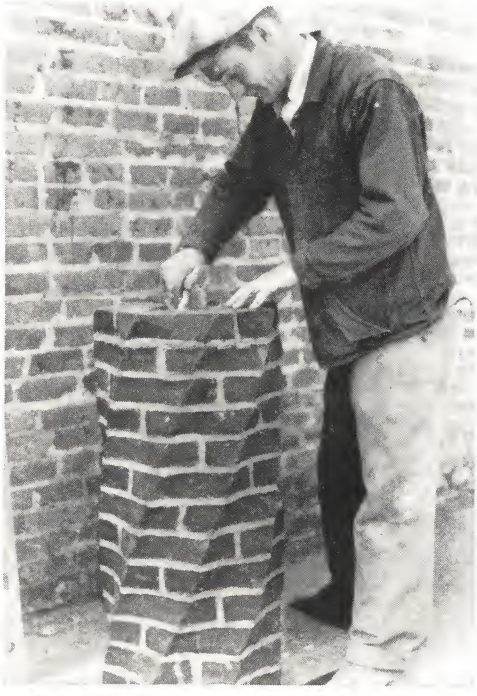


Figure 135.—Laying up a spirally-molded brick chimney.

buildings and for the construction of gutters of public and private driveways.

Brick are frequently used in combination with stone and tile, as well as with concrete. Very pleasing effects have been obtained by using combinations of these materials, as shown in figure 137.

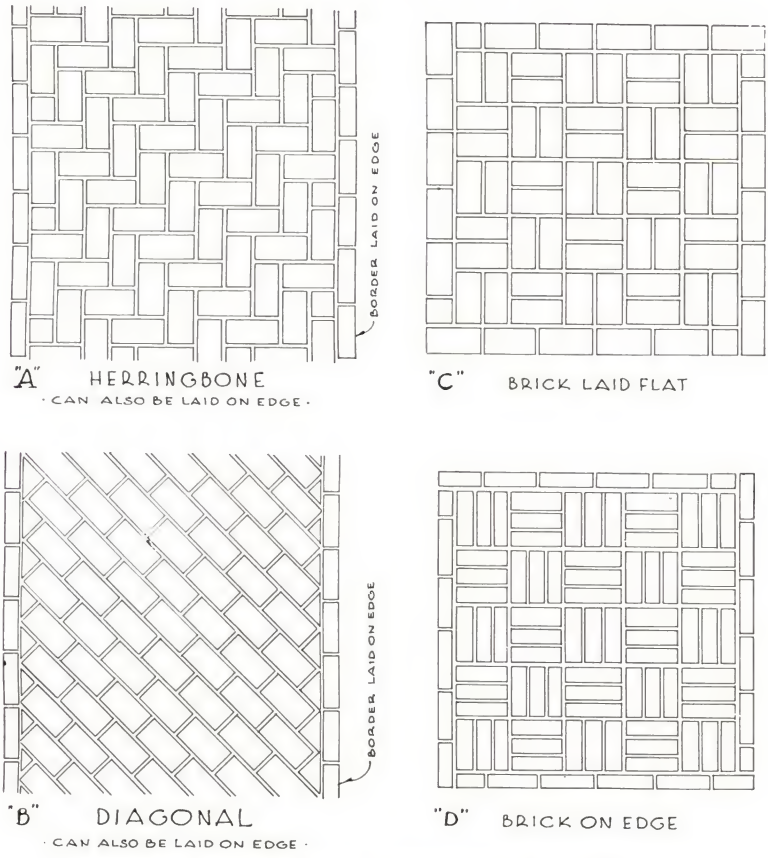


Figure 136.—Pattern design used for garden walks.

Design "A" shows a herringbone or "stepped" pattern.
Design "B" is a diagonal pattern.
Design "C" is a basket-weave pattern composed entirely of brick laid flatwise.
Design "D" shows the basket pattern made up of brick laid on edge.

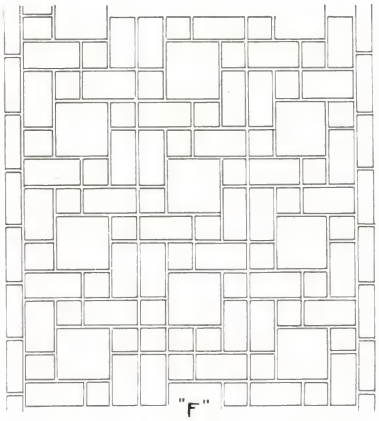
Methods of laying.

When brick are used for porch or terrace paving, they are usually laid over reinforced concrete slabs. The brick themselves may also serve as a reinforced slab if the span is not too great and the design lends itself to straight lines. In this case, steel rods are used as tension members near the bottom of the mortar joint. Bricks are also laid on

a sand base which is satisfactory for walks and, in some instances, terrace pavings. In colder sections of the country, where the soil is subject to freezing and thawing, a well-constructed, reinforced concrete base should be used. Hard-burned brick laid in concrete mortar should be used for this type of construction.

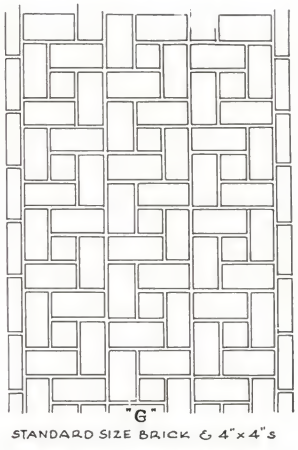
Designs in paving.

Patterned brick walks and paving present a very effective appearance and are much more decorative when laid out in pleasing design. Examples of a few of the paving patterns used with standard-size brick are illustrated by figures 136, 137, and 139.



Garden steps.

Garden steps constructed of brick in connection with brick walks are of several types. See figure 140. All steps, no matter what pattern is used in the brickwork, should have a solid foundation of concrete laid on a bed of cinders, to protect the steps from any undue movement or frost action. The brick used in the treads of the steps may be laid flatwise or on edge. See figure 140. The size of the brick units makes it



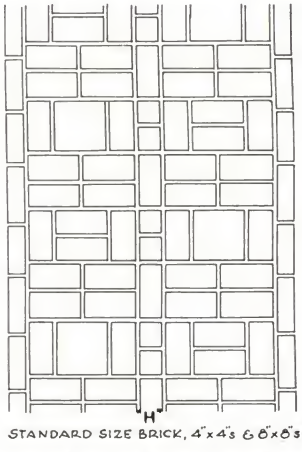


Figure 137.—Patterns for brick walks in which the brick are laid flatwise.

Design "F" shows a brick pattern composed of stretchers interspersed with double brick or quarry tile units.

Design "G" shows a pattern design in which whole or half brick are used with brick on edge on sides.

Design "H" pattern in which standard size brick, half brick and 8 x 8 quarry tile are used.

possible to adjust the treads and risers to secure an ideal proportion of the rise and tread for out-door steps.

Mortar joints.

If mortar joints in paving or steps are to be filled with mortar, it is advisable to go over the surface of the brick with linseed oil before the mortar or grout is spread over the brick to prevent the absorption of the mortar on the face of the brickwork. If this plan is followed the surplus mortar may be cleaned off the brick easily.

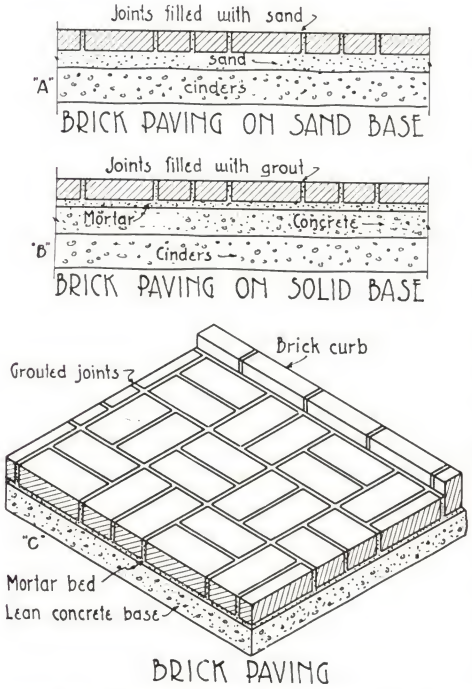


Figure 138.—Two types of brick walk construction.

Section "A" of this illustration shows the brick paving laid in a sand bed which has been spread over a cinder base.

Section "B" shows a concrete base laid over a cinder fill. The joints are filled with concrete mixture.

The isometric drawing "C" shows the method of laying brick paving with grouted joints and the brick curb at edge of paving.

IV. Details of Construction.

6. Special constructions.

***m*. Reinforced brickwork.**

Brick masonry reinforced with steel has been used for over 100 years. The first notable instance of the use of reinforced brick was in the construction of a tunnel under the Thames river in England. In the laying up of a brick shaft on the banks of the river wrought iron hoops were placed in the circular walls of the shaft. After the shaft was completed it was sunk into position by excavating the earth in the interior of the shaft. Reports of this pioneer effort in reinforced brick masonry state that the shaft was lowered to a depth of over 40 feet without injury to the walls.

Experiments carried on in this country and abroad by engineering colleges and trade associations have demonstrated the feasibility of the use of reinforced brick masonry for beams, floor slabs, and lintels in various types of building construction and for structural purposes in engineering projects such as conduits, bridges, abutments, dams, and the like.

Methods of reinforcing.

There is considerable flexibility in the methods of constructing forms for reinforced brickwork. It is not necessary to make the form

watertight and usually a form is required only to support the lower course of brick. In the construction of columns for walls of buildings, no forms are needed since the reinforcing material is embedded in the mortar joints.

The amount of reinforcing steel to be used in spans more than 8 feet in length, or in structures carrying a considerable load must be carefully worked out by engineers. Practically the same formulas are used in determining the amount of steel in brickwork as are used in reinforced concrete construction. As a general rule the weight of brick reinforced construction is somewhat lighter than reinforced concrete structures carrying the same load.

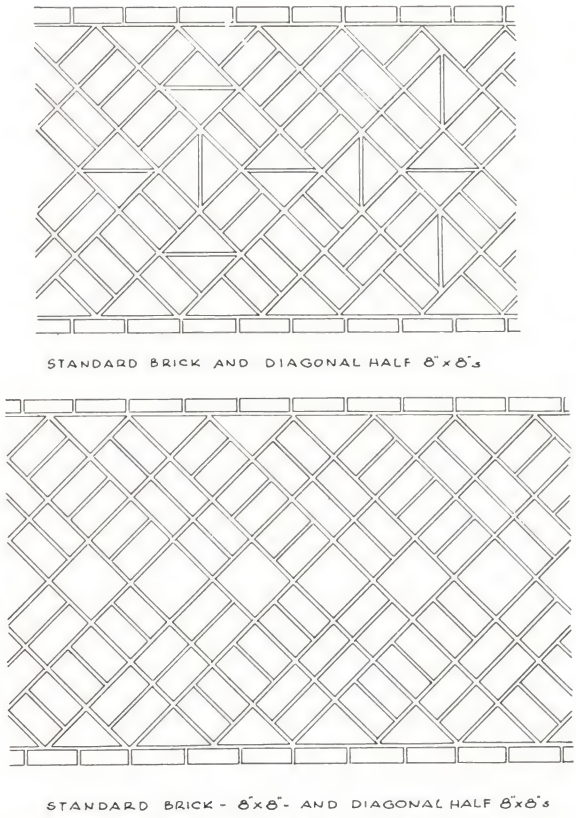


Figure 139.—A brick pattern design in which standard-size brick, square 8 x 8-inch brick, and diagonal ½ brick are used.

A simple reinforced brick lintel is constructed by laying brick directly on wood centering and placing reinforcing rods near the bottom of the lintel, usually in the first bed course. The size and number of rods depend on the span of the opening. Figure 142 illustrates the method of laying up a reinforced lintel in which the steel rods act as tension members. Openings as wide as 10 feet can be satisfactorily spanned by using rods in the bottom of the mortar joint of lintels, provided no additional load than the weight of the wall is to be carried.

Reinforcing rods may be used for both tension and compression in constructing beams in either 8- or 12-inch brick walls. Figures 143 and 144 illustrate the method of placing horizontal rods in a beam supported at intervals with steel stirrups. These stirrups are hung from the compression rods and are placed at definite distances be-

tween the centers. As shown in figure 143, the first course of brick is laid up as a soldier course. Because of the adhesive strength of the cement mortar used in laying up reinforced beams, the brick are held firmly in place by pressure and adhesion.

Reinforced brick slabs are used for floors and paving. (See figure 146.) In this type of construction the reinforcing rods are placed in the vertical joints and held in position near the bottom of the span by wire bar supports. Figure 146 shows how these reinforcing rods are held in place at the proper distance from the bottom.

Figure 145 illustrates the use of reinforcing rods in horizontal and vertical joints. This type of construction is used in parts of the country subject to earthquake shocks. It is also extensively used in laying up load-bearing walls such as supports for trestles, bridges, viaducts, and the like.

Leopold photo.

Figure 140.—Entrance to a residence showing use of brick in walk, steps, and porch floor.

Figure 141.—Interior view of the loggia illustrated in figure 134.

This illustration gives a more detailed view of the molded brick used in round columns and the use of segmental arch openings and circular window.

In laying up reinforced masonry walls or other structural brick units, no new technique is required on the part of the bricklayer. He should be aware, however, that the reinforcing rods must be completely covered with mortar. This requires about ⅛-inch additional thickness in the mortar bed so that the rods will be completely surrounded with mortar. The brick should also be free from dust and surplus water and the mortar used should be a mixture of relatively high strength, that is, of one part of cement and not to exceed ¼ part lime putty and 3 parts of sand. The brick should be of uniform strength, hard burned, and free from flaws.

Figure 14 shows a modern railway and highway bridge constructed of reinforced brickwork.

VIII. Applied Art.

1. Introduction.

Because of the fact that his training is largely directed toward acquiring skill and accuracy in the use of tools and masonry materials in producing a finished workmanlike job, the bricklayer may lose sight of the fact that he constantly applies the principles of art to his work, when he maintains straight lines in laying up a course, preserves symmetry or balance in constructing a wall, and harmonizes colors in arranging brick, mortar, and other masonry materials.

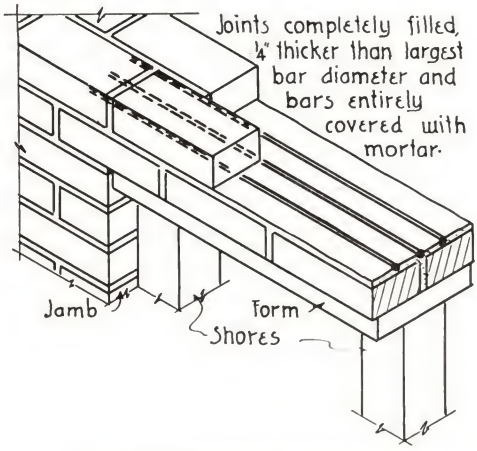


Figure 142.—Reinforced brick lintel.

Illustration shows the position of steel reinforcing rods in bed of an 8-inch brick wall.

Lines.

Where horizontal, vertical, or sloping lines appear in any type of construction these should continue throughout their course without irregularities, and if a number of lines on the surface of a building are parallel, either vertical or horizontal, they should be equidistant throughout the total distance of their course.

This principle of line as applied to design should be followed in other phases of bricklaying also. Bed joints in a brick course, for instance, should not only be spread straight and level, but parallel with other courses; and if the design calls for alternate header

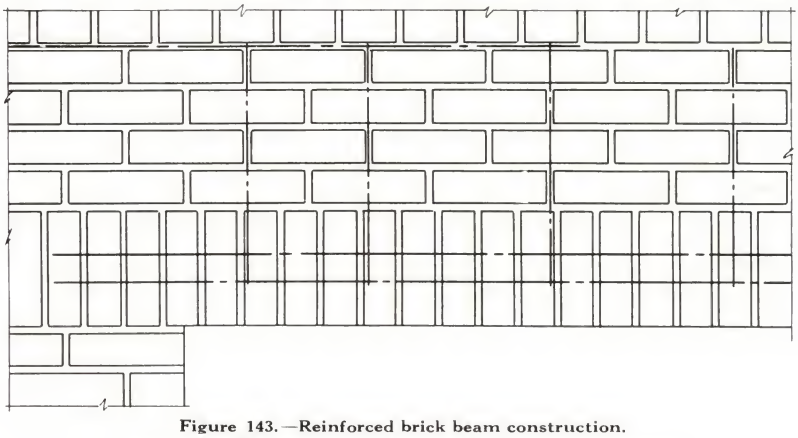


Figure 143.—Reinforced brick beam construction.

This drawing illustrates the bottom of beam laid up with soldier course.

courses the vertical lines of the joints should be over one another.

The opposite sides of parallel recessed panels on the vertical sides of a wall should be the same distance apart throughout the course. Somewhat the same effect of horizontal lines is produced in using recessed or stripped mortar joints. Figure 147 shows a continuous header course recessed back from the face line of the basement story. This indentation is repeated every sixth course, producing the effect of a continuous rustication by parallel lines spaced at a regular distance across the face of the building. Figure 147 shows further that the recessing of the course or the indenting of the mortar joints results in a shadow along the face of the wall. If the wall has been properly laid up with the lower edge of the stretcher course in line and a header course accurately recessed, the shadow cast on the wall will be a straight line and will give a pleasing appearance to what might otherwise be a plain expanse of wall surface.

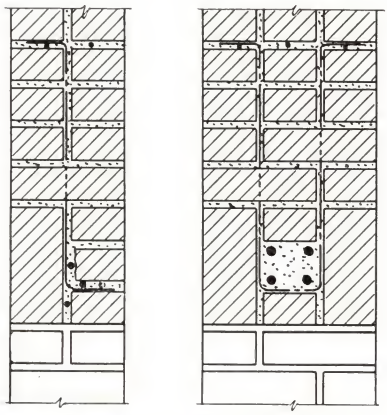


Figure 144.—Cross section of an 8- and 12-inch beam.

This illustration shows the position of reinforcing rods and the method of holding the tension rods in position by means of steel stirrups.

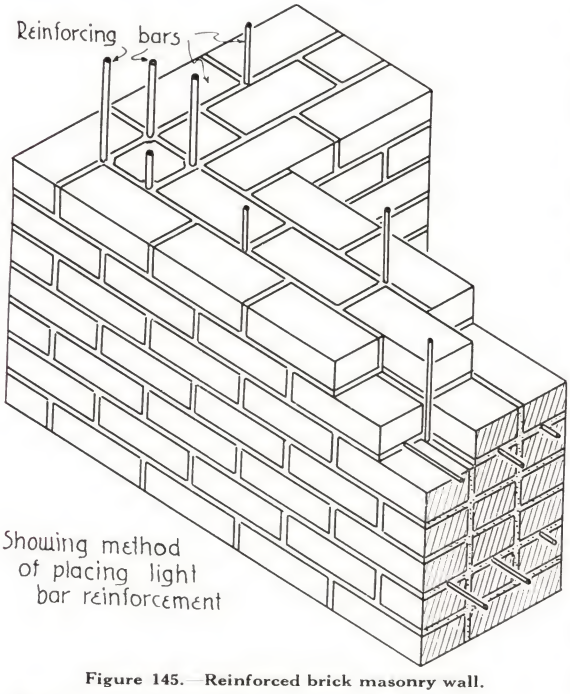


Figure 145.—Reinforced brick masonry wall.

Reinforcing rods are placed in bed and vertical joints. Where rods over ⅜-inch in diameter are used as uprights, it is necessary to clip the corners of the brick so the width of the mortar joints will not be increased.

If the design of the brick wall calls for alternate header courses, the alternate headers should be centered over one another to produce parallel vertical lines. The proper centering of these headers can be accomplished even with a rough and somewhat uneven-shaped brick by the skillful bricklayer if he will

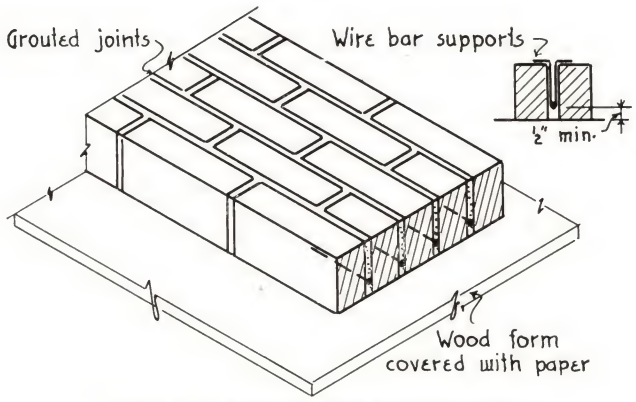


Figure 146.—Reinforced floor slab construction.

first lay out the run of the course for the entire length of the wall. This should be carefully done so that the openings will be in the correct location and the regularity of the bond pattern will be retained in the piers between the window and the areas of the walls above the window openings.

Figure 147.—Method of bonding the projecting brick of a rusticated brick wall.

A continuous header course recessed at every fifth course forms the groove between the rustications. The soldier course of molded brick caps the rusticated base wall.

If there are a number of recessed panels in the vertical sides of a wall these panels should be the same width at the bottom and the top. Figure 149 illustrates the use of horizontal, vertical, and diagonal lines in pattern brickwork in the construction of a stepped-back type of chimney. The lower panel of the chimney shown in this figure, stretcher and soldier courses are laid in a horizontal and vertical position, producing a rectangular framed panel. In the second panel a more elaborate pattern has been laid up using stretchers on vertical and diagonal lines. The recessed sections in the three upper panels of this chimney are composed of stretcher and header courses laid up to frame a rectangular-shaped panel.

Figure 148 shows an example of a vertical bond treatment of brickwork in the gabled walls of a brick building. These gabled walls are laid up in what might be termed a herringbone pattern. Other

examples of simple patterns in common brickwork are shown in figure 150.

The use of horizontal and vertical lines may be noted in the pattern effects produced by various bonds. The shape of brick material used in the construction of the buildings shown in figures 149 and 150 and the variety of horizontal and vertical joints that it is possible to produce in laying up brick make possible pattern arrangements of surfaces in either vertical or horizontal construction. The architect has made use of this possibility of securing variety in wall surfaces, in planning brick-constructed buildings. The appearance of well designed wall surface may be spoiled if the craftsman fails to follow the simple principle of keeping the lines in the patterns straight and parallel when the design calls for such an arrangement.

Figure 148.—View of the Cranbrook School, Cranbrook, Mich., showing combination of limestone trim and walls of patterned brickwork laid up with a rough-textured brick.

Figure 149.—Chimney stack at end of wing forming one of the design features of the Kingswood School at Bloomfield, Mich. Eliel Saarinen, architect.

This illustration shows several ways in which pattern brickwork can be utilized as a decorative medium in the ornamentation of buildings.

Figure 151 illustrates the use of a pattern design in the gable end of a building. The diagonal lines in the pattern determine the pitch of the roof.

Curved lines.

Because of their relatively small size the materials used in brickwork can be laid up to follow the outline of curved surfaces both in plan and

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elevation. In the circular or segmental arch laid up over door or window openings, the eye, in following the curved line, expects to see the line continue in the direction it has taken. In a smooth rowlock arch the eye follows the slope of the joints between the bricks and locates the center which was used in laying up the arch. If there is a variation in the slope of the skewback or in the width of the mortar joints, this inaccuracy is quickly detected. In looking at a pattern design which is intended to be circular, one expects the lines in the design to conform to the outline of a circle.

Figure 150.—Wing of Fine Arts Building at Cranbrook School, Cranbrook, Mich.

An excellent example of brickwork laid up in common bond. Rowlock relieving arches are used over the lintels of windows of first story. This introduces a pleasing pattern in the plain wall surface over these windows.

Figure 157 shows a design forming a circular panel in a vertical wall. The purpose of this panel is to break up the plain appearance of a wall surface. In this design the outline of the bird is formed of cut brick and tile and it will be noticed that the field within the circle continues the bond pattern of the surrounding wall.

An example of brickwork laid up to a curved line in plan is illustrated in figure 153, which shows the restoration of the original Capitol building of colonial Virginia. Not only are the two wings in this structure curved in plan, but the curved walls are pierced with circular windows. Another example of curved lines in plan is shown in the outside entrance steps and platform, illustrated in figure 156.

Figure 154 also shows an interesting example of the way in which a semicircular wall is joined to the straight side of a building by overlapping the bricks at the corners, thus forming a key bond.

This joining is done without trimming off the ends of the brick.

Figure 152 shows a building designed in the Romanesque style of architecture. Semicircular arches are laid up over window openings in basement, chapel, and tower. The decorative cornice also has circular topped arches. Figure 158 shows an

arched brick ceiling laid up in a simple stretcher pattern around a central recessed pattern.

Symmetry.

The bricklayer needs to be continually on the watch to see that his work is not only structurally sound but also pleasing in appearance. The general appearance of the surface may be marred if, for instance, opposite corners which are structurally the same are not symmetrically laid up. If there are several openings of the same size the bricklayer should use his judg-

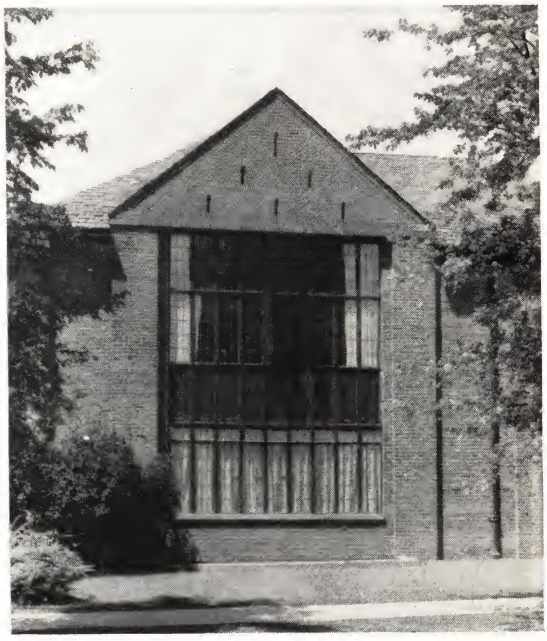


Figure 151.—Mullioned window showing an interesting wall pattern treatment in the brickwork of gable.

The lintel course over window is composed of a projecting rowlock course surmounted by a flush soldier course. The brickwork of the walls below is laid up with rough brick, projecting slightly from face of wall, producing an interesting texture in the surface of the wall.

Figure 152.—Chapel of Convent, Villa Saint Felix, Plymouth, Mich. O'Meara & Hill, architects.

Showing the use of brick in combination with cut limestone trim in the Romanesque style of architecture. Half-round bays project from corners of octagonal central tower.

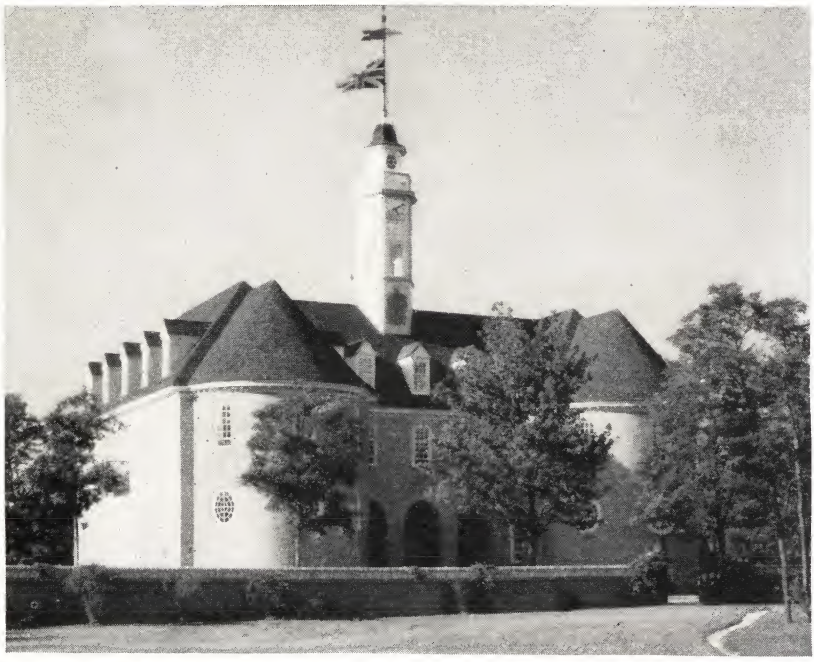


Figure 153.—The old colonial Capitol of Virginia, Williamsburg, Va., Restoration. Perry, Shaw & Hepburn, architects.

Figure 154.—Detail of Kingswood School, Cranbrook, Mich., showing various brickwork features.

This illustration shows the method of joining semicircular end wall of building with straight side wall without trimming off the ends of the brick.

ment in laying out the bonds on each side of the opening. Securing the proper symmetry in a wall surface involves laying out the bonds of the wall so that the interruptions where open spaces are required, such as doors and windows, will not interfere with the continuation of the bond arrangement above and below these openings.

To show how the principle of symmetry may be applied it may be pointed out that where there are a number of pilasters on the exterior of a wall and these pilasters are supposed to be placed at regular

Figure 155.—Entrance Lodge to Divinity School group, Yale University, New Haven, Conn. Delano & Aldrich, architects.

Brick laid up in Flemish bond in a modern building designed in a pleasing adaption of the colonial style. A molded brick water-table course is used in this octagonal-shaped building.

intervals and to be uniform in size, there should be no variation in the building of these pilasters even though the various sections of the wall are laid up by different bricklayers.

Figure 155 illustrates symmetry or balance on the sides of window and door openings. Figure 150 shows a good example of the arrangement of bonds in piers between window openings.

Color.

The bricklayer may not have much to do with choosing the color of the brick or mortar for a particular job. These are matters for the

Figure 156.—Main entrance to Chapel, Divinity School group, Yale University, New Haven, Conn.

Illustrates a pleasing arrangement of white-painted woodwork and dark-painted metal work combined with brickwork. The brickwork of this building is laid up in Flemish bond with a rather narrow mortar joint.

architect and the owner to decide. There is, however, a certain amount of knowledge of color arrangement that a bricklayer should possess. For example, if a wall surface is to be laid up with uniform-colored brick and there happens to be in the pile a few brick that are "off shade," the bricklayer should discard these brick rather than lay them in the wall and spoil the finished appearance of the surface. In following the modern practice of using rough-surfaced brick, ranging in shades of color from light to dark, more judgment is required on the part of the bricklayer in placing these brick in a harmonious arrangement than if the brick are of uniform color.

Figure 157.—Pattern design in brick in a plain wall surface.

The principle usually followed in work of this kind, provided the surface is large, is that the various colors should be distributed evenly throughout the surface. It is much better, if the wall is intended to be blended, to have these various shades distributed promiscuously over the wall surface without any thought of following out a definite order. If the surface is small, as in a wall panel or in a fireplace facing, more care should be taken in selecting the proper shades than would be necessary in arranging these shades in a larger surface.

If a sharp contrast between the brick and mortar joints is desired, care should be taken to select the coloring for the mortar so that the mortar will blend in with the general shade of the brick.

The colored plate on the frontispiece of this bulletin shows a contrast of harmonious colors between brick and mortar joints. It will be noted that three rather distinct shades of color are used in the brick in the walls and for the trim of the windows and doors in the building illustrated. The deeper-red brick used for the trim, belt course, and corners is produced by rubbing the surface of the brick

with an abrasive stone. This rubbing removes the lighter-colored glazed surface of the brick.

The plain wall surfaces in this building are laid up with wider joints, and a contrast of color is secured in the surface of the wall by the use of glazed headers in Flemish pattern bond. A more detailed view of the gateway and entrance front illustrated in figure 159 shows that a deeper-red-colored brick has been used for the trim and flashed headers.

Figure 158.—Arched-brick ceiling laid up in simple stretcher pattern around central-recessed panel.

A somewhat different effect is shown in the upper illustration in figure 159. The brick in the older building at the right has been laid up in Flemish bond pattern, with mortar colored to blend with the general color of the brickwork in the wall; and the brick in the new portion of the building on the left has been laid up with a lighter-colored and, consequently, more contrasting mortar. In all three of the illustrations included in figure 159 a pleasing contrast is presented between the white-painted woodwork and the light gray of the limestone used as a trim.

A house or building of mediocre design may be changed to one that is pleasing and distinctive in appearance by harmonizing the color of brick and mortar used in the walls. The color of mortar has a great deal to do with the general appearance of a wall surface.

Before the actual construction of a building is started the bricklayer foreman is frequently called upon to lay up a sample of the bond to be used with several types of mortar joints. From these samples the owner and architect determine the color of mortar and the character of mortar joint to be used. It is necessary that the same color of mortar be used throughout the surface and the bricklayer should be sure that mortar ingredients are the same color.

Architects are continually working out new combinations of color in surfaces of walls and are using in many instances brick of various shades to express their ideas. It is necessary, therefore, for the bricklayer to have some appreciation of color arrangement so that he may assist the architect in securing the desired color effect.

Instructor should provide illustrative material.

It will be well for the instructor to collect photographs illustrating various construction points discussed above. Many illustrations published in magazines may be used for this purpose. The instructor should collect a few photographs showing examples of distorted horizontal and vertical lines in brick walls as well as examples of well-constructed buildings. The various associations representing the manufacturers of bricklaying materials have printed illustrations showing examples of the proper use of their materials.

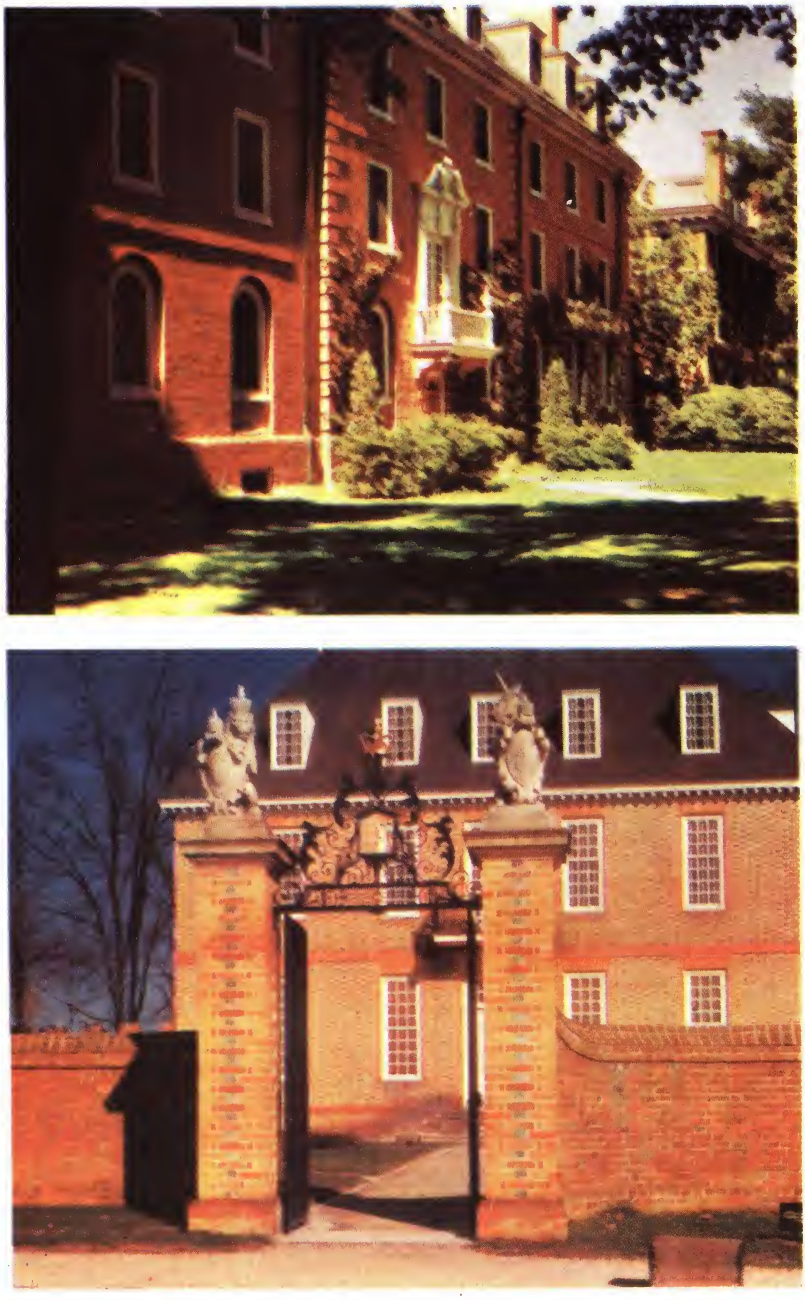


Figure 159.—(Upper view) Facade of a New England school building. One of the residence halls of Philip Exeter Academy at Exeter, N. H.

The photograph shows the contrast between the brickwork and the white-painted window frames and balcony and the softening effect produced by shrubbery planted about the building.

(Lower view) Entrance gateway and wall enclosing the forecourt of the Governor's Palace, Williamsburg, Va., Restoration.

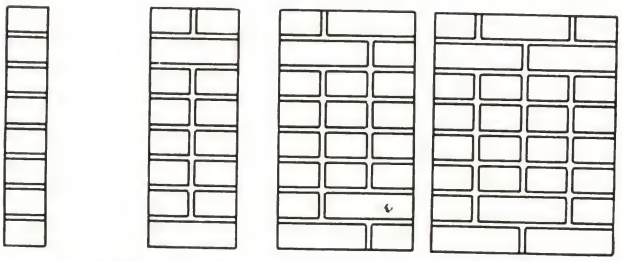
A fine example of colonial brickwork in combination with cut stone and ornamental iron. The photograph shows the contrast in color between the sand-molded brick used in walls, and the deeper-red rubbed brick used for trim.

Appendix A.—QUANTITIES OF MATERIALS FOR CLAY PRODUCTS MASONRY CONSTRUCTION

Table V gives the brick and mortar requirements for solid brick walls 4, 8, 12, and 16 inches in thickness with ½-inch mortar joints. In estimating the number of facing brick required for various bonds it is necessary to increase the quantities shown for 4-inch walls to provide for the number of full headers to be used.

For example, if the facing brick are to be laid in common bond with

Table V.—Brick and mortar required for solid brick walls. Mortar joints are ½-inch in thickness



Area of wall	4-inch wall		8-inch wall		12-inch wall		16-inch wall	
	Number of brick	Cubic feet of mortar	Number of brick	Cubic feet of mortar	Number of brick	Cubic feet of mortar	Number of brick	Cubic feet of mortar
1	6.2	0.075	12.4	0.195	18.5	0.314	24.7	0.433
10	62	1	124	2	185	3½	247	4½
20	124	2	247	4	370	6½	493	9
30	185	2½	370	6	555	9½	740	13
40	247	3½	493	8	740	13	986	17½
50	309	4	617	10	925	16	1,233	22
60	370	5	740	12	1,109	19	1,479	26
70	432	5½	863	14	1,294	22	1,725	31
80	493	6½	986	16	1,479	25	1,972	35
90	555	7	1,109	18	1,664	28	2,218	39
100	617	8	1,233	20	1,849	32	2,465	44
200	1,233	15	2,465	39	3,697	63	4,929	87
300	1,849	23	3,697	59	5,545	94	7,393	130
400	2,465	30	4,929	78	7,393	126	9,857	173
500	3,081	38	6,161	98	9,241	157	12,321	217
600	3,697	46	7,393	117	11,089	189	14,786	260
700	4,313	53	8,625	137	12,937	220	17,250	303
800	4,929	61	9,857	156	14,786	251	19,714	347
900	5,545	68	11,089	175	16,634	283	22,178	390
1,000	6,161	76	12,321	195	18,482	314	24,642	433
2,000	12,321	151	24,642	390	36,963	628	49,284	866
3,000	18,482	227	36,963	584	55,444	942	73,926	1,299
4,000	24,642	302	49,284	779	73,926	1,255	98,567	1,732
5,000	30,803	377	61,605	973	92,407	1,568	123,209	2,165
6,000	36,963	453	73,926	1,168	110,888	1,883	147,851	2,599
7,000	43,124	528	86,247	1,363	129,370	2,197	172,493	3,032
8,000	49,284	604	98,567	1,557	147,851	2,511	197,124	3,465
9,000	55,444	679	110,888	1,752	166,332	2,825	221,776	3,898
10,000	61,605	755	123,209	1,947	184,813	3,139	246,418	4,331

a full header every 5th course, it will be necessary to increase the brick quantities listed for 4-inch walls by ⅕ to obtain the required quantity of facing brick, and to reduce the quantity of back-up brick by the same amount. If common bond is used with a full header course every seventh course, it will be necessary to increase the quantity of facing brick by one-seventh, and the back-up brick by the same amount.

For English bond, which is a full header course every 2d course, it will be necessary to increase the quantity of facing brick by one-half, and to reduce the back-up brick by the same amount.

For Flemish bond, in which full headers are used throughout, the quantity of facing brick will have to be increased by ⅓. For common bond with a Flemish header course every 5th course, quantity of facing brick will have to be increased by 1/15. If half brick or blind headers are used in Flemish bond with full headers and the full headers are placed at every 5th course, the facing brick requirements are the same as for common bond with Flemish header course every 5th course.

Table VI gives the number of tile of various standard sizes required for one square foot of wall area of varying thicknesses. It will be noted that tile are adapted for use only in walls where the thickness is the same as the thickness of the tile or a multiple of this dimension. The exception to this rule is the 12-inch wall which may be constructed of 8-inch and 3¾-inch tile bonded together.

Table VI.—Number of tile of varying sizes required in a square foot of wall area, allotting for ample coverage [1]

Size of tile in inches	Wall thickness					
	4 inches	5 inches	6 inches	8 inches	10 inches	12 inches
3¾ x 5 x 12 side construction	2. 4	3. 0				(2. 4)
8 x 5 x 12 side construction		1. 5		2. 2		(2. 4)
3¾ x 12 x 12 end construction						4. 0
4 x 12 x 12 end construction	1. 0					3. 0
6 x 12 x 12 end construction			1. 0			2. 0
8 x 12 x 12 end construction				1. 0		1. 5
10 x 12 x 12 end construction					1. 0	1. 2
12 x 12 x 12 end construction						1. 0
8 x 6½ x 12 side construction (interlocking)				2. 5		
8⅛ x 10¼ x 12 side construction (H-shaped)				1. 2		
8 x 8 x 8 cube				2. 2		3. 3

[1] A 12-inch wall side construction may be built up by bonding 3¾ x 5 x 12 inches and 8 x 5 x 12 inches tile together.

Table VII shows the quantities of mortar required for laying one thousand pieces of hollow tile of varying sizes.

Table VII.—Quantities of mortar required for laying 1,000 pieces of hollow tile of varying sizes [1]

Size of tile (inches)	Thickness of wall	Position laid	Cubic feet mortar
Partition tile:			
4 x 12 x 12	4 inches	End or side	22. 2
6 x 12 x 12	6 inches	End or side	22. 2
Load bearing tile:			
3¾ x 12 x 12	3¾ inches	End or side	21. 5
6 x 12 x 12	6 inches	Side	30. 0
6 x 12 x 12	6 inches	End	26. 0
8 x 12 x 12	8 inches	Side	37. 6
8 x 12 x 12	8 inches	End	33. 2
10 x 12 x 12	10 inches	Side	45. 3
10 x 12 x 12	10 inches	End	33. 2
12 x 12 x 12	12 inches	Side	52. 9
12 x 12 x 12	12 inches	End	37. 1
3¾ x 5 x 12	3¾ inches	Side	17. 3
8 x 5 x 12	8 inches	Side	33. 4

[1] In the column showing size of tile, the first number indicates the thickness of wall, the second the width of tile, and the third the length to which it is cut. All of these dimensions are in inches.

Mortar required for a 16-inch wall or thicker wall may be obtained by adding the quantities necessary for tile used to make the required thickness.

The method in computing the above table in general is as follows:

All joints are assumed to be ½ inch thick. Mortar for tile laid on the side should cover the entire horizontal or bed joints, and for tile laid on end 1 inch each on outer and inner vertical joints.

For tile laid on end, the longitudinal shells and webs should have 1 inch width of mortar on the horizontal or bed joints; no mortar on the cross shells and webs; and on 6-inch tile and 8-inch double shell tile, 2-inch width of mortar on both inside and outside of vertical joints.

On the 8-inch, 10-inch, and 12-inch 6-cell tile the vertical joints should have 3 inches of mortar on both inside and outside. This leaves an air space of 2 inches, 4 inches, and 6 inches in these vertical cross joints.

Appendix B.—APPRENTICESHIP AGREEMENT BETWEEN EMPLOYER'S AGENT AND APPRENTICE

THIS AGREEMENT, entered into this ____ day of _____, 19 ____, between _____ hereinafter referred to
(Name of Employer's Agent)
as the EMPLOYER'S AGENT, and _____ born _____ _____ hereinafter referred to as APPRENTICE, (and if a minor) name of PARENT or GUARDIAN, _____ hereinafter referred to as his PARENT or GUARDIAN.

Witnesseth that the EMPLOYER'S AGENT, the APPRENTICE and his PARENT (or GUARDIAN) desire to enter into an agreement of apprenticeship in conformity with the standards of the Michigan Apprenticeship Council, and therefore, in consideration of the premises and of the mutual covenants herein contained, do hereby mutually convenant and agree as follows:

That the EMPLOYER'S AGENT shall use its best influence to find employment for the APPRENTICE for the purpose of enabling said APPRENTICE to learn and acquire the trade or craft of _____ upon the terms and conditions contained in the schedule on the reverse side of this agreement and made a part hereof, and to require each EMPLOYER to sign an agreement to fulfill the terms of this agreement during each period of such employment.

That the APPRENTICE shall perform diligently and faithfully the work of said trade or craft during the period of apprenticeship in conformity with the terms and conditions contained in the schedule on the reverse side of this agreement, and made a part hereof.

That the PARENT (or GUARDIAN) guarantees that the apprentice will duly perform all obligations undertaken herein.

That the apprenticeship term begins on the date shown in the agreement signed by the employer, and terminates upon the completion by the APPRENTICE of _____ (years or _____ hours) of employment under guidance of said employer's agent in said trade or craft as stipulated in the said schedule.

That each agreement made by an employer for the employment of an apprentice is subject to the approval of the State Apprenticeship Council; that after such approval, annulment may be made by said Council upon the mutual consent of all parties to the agreement, or upon the recommendation of the Joint Apprenticeship Committee, or upon the said Council's own motion after giving all parties notice and opportunity to be heard. Except that the employer's agent shall have the right to transfer the apprentice from one employer to another upon receipt of a release from the old employer and an agreement from the new employer. During the probationary period stipulated in the schedule, such annulment will be made by the Council upon the recommendation of the local joint apprenticeship committee.

That any disagreement or difference in relation to the agreement that may arise between the parties hereto shall first be referred to the local joint apprenticeship committee for adjustment, providing either party may appeal the decision of such committee to the Michigan Apprenticeship Council, whose decision shall be final and conclusive upon the parties.

In Witness whereof the parties hereunto set their hands and seals:

_____ (Seal) _____ (Seal)
(Apprentice) (Employer)

_____ By _____ (Seal)
(Address) (Officer)

_____ (Seal) _____
(Parent or Guardian) (Address)

Approved by the _____ Joint _____ Apprenticeship Committee.

By _____ on _____, 19 ____

(Reverse side)

Approved by the Michigan Apprenticeship Council
Affiliated with the
Federal Committee on Apprenticeship

By _____ on _____, 19 ____

3. WAGE PROVISIONS.

The wage rate for journeymen _____ in _____ on _____, 19 ____ is _____.

The apprentice shall be paid for the—

1st 6 months _____% of Journeymen's wage rate.
2d 6 months _____% of Journeymen's wage rate.
3d 6 months _____% of Journeymen's wage rate.
4th 6 months _____% of Journeymen's wage rate.
5th 6 months _____% of Journeymen's wage rate.
6th 6 months _____% of Journeymen's wage rate.
7th 6 months _____% of Journeymen's wage rate.
8th 6 months _____% of Journeymen's wage rate.
9th 6 months _____% of Journeymen's wage rate.
10th 6 months _____% of Journeymen's wage rate.

4. HOURS OF WORK AND OF APPROVED INSTRUCTION.

The apprentice shall enroll and attend classes for a minimum of _____ _____ per year or _____ per week for _____ weeks. Hours of schooling are counted as part of the term of apprenticeship.

5. SPECIAL PROVISIONS.

The terms and conditions of the Local _____ Apprenticeship Standards are hereby made a part of this agreement.

NOTE.—Related and supplemental instruction as approved by the State board of control for vocational education and the local joint apprenticeship Committee, to be administed by the local board of education.

RELATED AND SUPPLEMENTAL INSTRUCTION:

Approved by _____ _____, 19__
(State Board of Control for Vocational Education)

Approved by _____ _____, 19__
(Local Joint Apprenticeship Committee)

This agreement form was jointly prepared and approved by the Michigan Apprenticeship Council, affiliated with the Federal Committee on Apprenticeship, United States Department of Labor and the State Board of Control for Vocational Education.

MASON CONTRACTORS, AND BRICKLAYERS LOCAL UNION NO. 5, CLEVELAND, OHIO

APPRENTICESHIP CONTRACT

This indenture, made this _____ day of _____ A. D. 19__ witnesseth that _____ (apprentice) party of the first part, of _____ in the County of Cuyahoga and State of Ohio, now the age of _____ years, with the consent of _____ (parent or guardian), party of the third part, his _____ hereon endorsed, does of his own free will, bind himself to serve _____ (Contractor), party of the second part of _____ in the County of Cuyahoga and the State of Ohio as apprentice in Bricklaying to said _____ (Contractor), party of the second part for the term of 4 years, but not less than 600 days, to wit: from the date thereof until the _____ day of _____ A. D. 19____, during all of which time the said apprentice shall serve his employer faithfully and honestly, and obey his lawful directions connected with said trade: and will not engage in said art or trade on his own account during the term of his apprenticeship, and will remain faithfully in the employ of said party of the second part for the purpose herein mentioned, unless sick or unable to work, and further agrees to attend the apprentice school at such times as the Apprentice Committee designates. Party of the first part voids this contract by his absence from his work for a period of thirty (30) days, or if he fails to return to the employer to whom he is indentured within ten (10) days after due notification, if in the opinion of the Apprentice Committee said absence has been willful and unnecessary.

The party of the first part binds himself to observe all laws, rules, and regulations of the Bricklayers, Masons and Plasters International Union of North America and Bricklayers and Masons Local Union No. 5, Ohio, pertaining to apprentices, and further binds himself to faithfully observe and carry out any and all rules, regulations and orders governing apprentices, made by any authorized committee of the said union.

Now, therefore, that said party of the second part has agreed to accept said party of the first part as an apprentice to learn the said trade of a bricklayer

upon the following terms and conditions, which are agreed to by said first and third parties as follows:

(1) Party of the second part hereby agrees to pay said party of the first part the following sums of money for pay or wages.

First Six Months, 32% Third Six Months, 42% Fifth Six Months, 54%
Second Six Months, 36% Fourth Six Months, 48% Sixth Six Months, 62%
Seventh Six Months, 70% Eighth Six Months, 80%

These rates are based on journeymen bricklayers' rates per hour; any change in said rates will make a proportionate change in these rates. The percentages in the contract concerning wages are subject to change at any time at the discretion of the Apprentice Committee.

Party of the second part further agrees to permit attendance of the party of the first part at the Apprentice School during the hours designated by the Apprentice Committee, and to pay said firstparty for such designated hours as he attends school at his established rate per hour. Party of the second part also agrees to provide party of the first part with employment at his trade during his term of apprenticeship, when possible, or to make an effort to secure employment for said party of the second part with some bona fide mason contractor at the trade herein mentioned. Party of the second part also agrees to pay party of the first part the same established rates of Union No. 5, Ohio, when employed outside of its jurisdiction.

If said party of the second part has not furnished said party of the first part with employment for a period of ninety (90) days and if in the opinion of the Apprentice Committee, said party of the second part has not made a determined effort to secure employment for said party of the first part, this contract may be declared null and void.

This contract may be cancelled at any time with the consent of the Apprentice Committee.

All parties further agree to comply with all rules and regulations formulated now or hereafter by the Apprentice Committee.

IN WITNESS WHEREOF, the parties hereto have set their hands and seals the day and year first above written.

Signed, sealed, and delivered in the presence of

---------- Contractor

---------- Apprentice

Parent or
---------- Guardian

No. ----------

SAMPLES OF BRICKLAYER APPRENTICE APPLICATIONS

CONTRACTOR'S APPLICATION FOR BRICKLAYER APPRENTICE

(Must be filled out with ink)

Name of firm _____ Date _____
Address _____ Telephone No. _____
Number of years in contracting business under the above name (immediately preceding this date) _____
Apprentice applicant's name _____ Address _____
Is he a relative _____ If so, what relationship _____
If not, how long have you known him _____
Is he now in your employ _____ If so, how long _____
In what position _____
Average number of bricklayers employed by you throughout the year _____
Number of bricklayers now in your employ _____
Principal type of building you do _____
List four jobs, each year. The last two years and location _____

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

How long will your present jobs continue _____
Will you keep this apprentice in your employ as long as you have bricklayer work of any kind _____
Do you understand that applicants are started with a thirty-day trial period _____
From whom do you buy material _____

_____ Monthly average _____
_____ Monthly average _____
_____ Monthly average _____

Do you intend to interest yourself in the progress of this apprentice and comply with the rules and regulations of the apprentice committee _____
Are you willing to pay an apprentice for time spent at school during the hours designated by the committee _____
Do you feel that you do sufficient work to keep an apprentice employed for four years _____
If this applicant is rejected, would you be willing to take another _____
Have you ever had a bricklayer apprentice serve his time with you _____
How many _____
Has your application for a bricklayer apprentice ever been denied _____
Have you previously appeared before this Committee _____

Signed _____
(Must be signed by member of firm)

Name of representative of the firm appearing before the committee _____
Date of appearance _____
Remarks:

To be attached to Apprentice Application Form and delivered by applicant to Bricklayer Apprentice Committee, Room C1702, Builders Exchange Building, Cleveland, Ohio, Cherry 5760

No._____

BRICKLAYER APPRENTICE APPLICATION

(Must be filled out in ink in applicant's own handwriting)

Name _____ Date _____
Address _____ Telephone No. _____
Place of birth _____ Date of birth _____
Parents' nationality: Mother _____
Father _____
If you were not born in this country, how long have you been here _____
Your height _____ ft. _____ in. weight _____ lbs.
Married or single _____ How long in this city _____
Father or guardian's name _____ His address _____
Is he a citizen _____
Have you any physical defects _____ if so, explain _____
_____
Your general physical condition _____
_____

LAST THREE OCCUPATIONS

From month and year	To month and year	Employer	Employer's address	Employer's business	Your position

Present occupation _____

Schools attended: Years attended

Name of school _____ City _____
Number of years attended _____ Day or night school _____
Name of school _____ City _____
Number of years attended _____ Day or night school _____

RELATIVES ENGAGED IN CONTRACTING OR ANY BUILDING TRADES

Name	Relationship	Occupation	Address

Name	Occupation	Address
Recommended by: _____		

Name of contractor who will give you a trial _____
Address _____
Do you understand that you will be on a 30-day trial if your application is approved _____
Are you willing to work for the established wage scale for bricklayer apprentices throughout your indentureship _____
Have you ever worked at bricklaying _____
If so, when _____ Where _____ For whom _____
Will you obey all rules and instructions of the apprentice committee _____
Are you willing to serve an apprenticeship of four years _____
Will you place yourself under the jurisdiction of the apprentice committee _____
Do you understand that it is compulsory for you to attend the apprentice school, during the hours designated by the apprentice committee, and that you will be accountable to the teacher during that time _____

(TO BE SIGNED BY EMPLOYERS AND TEACHERS, OTHER THAN RELATIVES)

I have known _____ for two years or more, and certify that he is of good character and habits.

PERSONAL SIGNATURES OF VOUCHERS

Name	Address	Business
_____	_____	_____
_____	_____	_____
_____	_____	_____

FOR THE COMMITTEE

APPROVED

1. _____
Mason Contractors' Association.

2. _____
Bricklayers Local Union No. 5.

Disposal:
On trial from _____ to _____
Firm _____
Date of first appearance before committee _____
Remarks:

To be attached to Contractor's Application Form and delivered by applicant to Bricklayer Apprentice Committee, third floor, Rose Building, Cleveland

Appendix C.—EXCERPTS FROM SPECIFICATIONS ISSUED BY UNITED STATES GOVERNMENT CONSTRUCTION DEPARTMENTS APPLYING TO THE USE OF STRUCTURAL CLAY PRODUCTS

Federal Works Agency
Public Buildings Administration
(From Standard Specifications)

BRICKWORK

67. *Laying common brick.*—Unless otherwise directed by the Construction Engineer, brick shall be drenched with water, allowed to drain and shall be damp when laid. Each brick shall be shoved into a full mortar bed and all joints shall be filled, leaving no voids. Where brick are laid against concrete, metalwork or waterproofing, the joints next to same shall be slushed or grouted full as each course is laid.

68. Every sixth course in the height of common brickwork shall be a full-brick or overlapping header course extending through the wall or to the facing. Brick piers shall be bonded throughout each course. Joints that will be concealed in the finished work shall be cut off flush. Exposed face joints of exterior work shall be weathered and of interior work shall be neatly struck. Brick sills in unplastered spaces shall be laid on edge and the joints finished flush.

69. Brick backing of stone and terra-cotta facing shall be laid to come flush with the horizontal joints of stone or terra cotta. The stone or terra cotta shall not be built up more than two courses above the backing, and no piece of stone or terra cotta having a greater depth of bed than the one below it shall be set until the lower course is backed up.

70. Brickwork shall be plumb, true to line and with courses level. All metalwork required shall be built in as the work progresses. Brick masonry shall be bonded or anchored to abutting concrete or tile work.

71. Suitable recesses shall be provided for built-in radiators, cabinets, junction boxes, etc. Exact size and location of recesses not indicated shall be as required by the mechanical equipment.

72. Brick corbels or ledges shall be formed as required or necessary for the proper support of facing or structural work, and, for projections of more than 2 inches, shall finish with a header course.

74. Arches without lintels shall be turned on rigid wood centers which shall be left in place until the mortar has set hard. Common brick arches shall have one rowlock for each 24 inches or fraction thereof in span, and no arch shall have less than two rowlocks. Flat arches shall have soffits cambered ¼ inch for every 4 feet of span.

75. Reglets for counterflashings shall be formed by building in a 1½-inch strip which shall be removed after the mortar has set.

76. Chases for pipes, conduits, etc., shall be plumb and smooth on the inside, with offsets formed where required. Chases shall be kept free of obstructions and shall be cleaned out on completion. There shall be at least 8 inches of masonry between chases and the jambs of openings.

22. *Face brick.*—Sizes of brick not otherwise indicated shall be the approximate dimensions given in Simplified Practice Recommendation No. 7 issued by the United States Department of Commerce with permissible variations between bricks of not more than ⅛ inch in breadth or depth nor more than ¼ inch in length for rough-face brick, and not more than $^{1}/_{16}$ inch in breadth or depth nor more than ⅛ inch in length for smooth-face.

FACE BRICK AND COMMON BRICK

SIMPLIFIED PRACTICE RECOMMENDATION NO. 7

Approximate Dimensions Expressed in Inches

Types	Length	Thickness	Width
Common brick	8	2¼	3¾
Rough-face brick	8	2¼	3¾
Smooth-face brick	8	2¼	3¾

23. Consideration will be given to face brick not of standard size, only when of a size adapted to the requirements of the bonding, jointing, and dimensions of the work to be done.
24. Special shaped face brick shall be provided for external angles other than 90 degrees, for curved surfaces of less than 6-foot radius, for pattern work and similar requirements. Face brick for borders and soldier course shall be gaged for length.
25. Face brick for jack arches and for segmental and semicircular arches (except single rowlock) shall be ground or specially made to give regular soffits and true radial joints of uniform width.
26. All special brick shall be of the same quality and have exposed faces of the same color and texture as the adjoining brickwork of the same kind, unless otherwise indicated on the drawing.
27. The following definitions shall be considered a part of the specification requirements when they are descriptive of the face brick noted on the drawings:
    a. Smooth-face brick shall include wire cut, repressed, dry press and water-struck brick that are smooth on the face. The wire cut surfaces of wire cut brick shall be the flat sides that are laid in the mortar.
    b. Water-struck brick shall be formed in wooden molds that are soaked in water and used wet to prevent any clay from adhering to the surface.
    c. Sand-face brick shall have a uniform surfacing of sand showing on the face and forming a part of the brick, and shall include sand-struck, sand-molded, and sand-finished brick.
    d. Mat-face brick shall be brick with wire cut faces and of fine to medium texture. Mat-face end cut shall have the striations of clay running vertical. Mat-face side cut shall have the striations of clay running horizontal.
    e. Rough-face brick shall be scored and rolled or have wire-cut faces of rough texture, as selected.
    f. Where select common brick are indicated for exterior facing, they shall be Class H of the color indicated on the drawings and shall be selected for uniformity of shape and size. They shall be furnished in the full range of natural colors obtained by burning and shall be laid with the best face exposed.
28. *Glazed and enameled brick* are included under "Glazed Structural Units".
59. *Laying face brick.*—Unless otherwise directed by the Construction Engineer, face brick shall be drenched with clean water and allowed to drain and shall be damp when laid. Brickwork shall be laid uniformly one scaffold high at a time. For the bond of face brickwork and the type of face joints required, see drawings and the Miscellaneous Standard Details noted thereon. * * *

60. Where select common brick are indicated or specified for exterior brick facing, the requirements for laying and jointing shall be the same as shown and specified for face brick.

All the headers in Garden Wall bond must be full-length brick. All the headers in alternate courses of Monks bond must be full-length brick. If Garden Wall Cross bond or Flemish Cross bond is used, consult the structural section as to the locations of full-length headers.

61. Except on concrete, every header course of common bond, every third header course of English bond and the headers in every third course of Flemish bond shall be full-length brick bonding with the backing. Brick laid in running bond shall not have headers, except where they occur in regular bond at returns and reveals, and shall be anchored to the backing by metal ties placed on alternate brick in every fourth course.

62. The bond of face brick shall be laid out and adjusted to each wall space so that no course shall finish at an external corner nor at a jamb with a piece less than 3¾ inches long, except that in English bond the courses may finish at the jambs of openings with headers and half headers (queen closers).

63. Where closers are required to maintain the bond in English or Flemish bond, they shall be placed symmetrically to the opening or the center lines of piers as may be directed. The use of closers shall be avoided where possible, and no closer shall be less than one-half the width of a full header.

64. Face brickwork shall be straight and true and the bond kept plumb throughout. Brick courses shall be level and accurately spaced. Variations in the width of vertical joints shall be inconspicuous and made only as necessary to maintain the bond. The brick shall be shoved into a full bed of plastic mortar and all joints shall be filled solid and face joints finished as indicated and specified.

65. All face joints of exterior brick facing shall be finished with a metal jointing tool to the profile indicated as soon as possible after the mortar has attained its initial set so as to compact the mortar in the joint, forcing it tight against the brick and closing all hair cracks and crevices. The use of "cut-off" joints will not be permitted in exterior brick facing.

66. Where exterior brick sills are indicated, the brick shall be laid on edge with wash and drip and all joints shall be filled solid with mortar. Joints in the wash of sills shall be finished smooth.

92. *Firebrick* shall comply with Federal Specification HH–B–671*b*, for moderate heat duty. Fire clay for mortar shall conform to Federal Specification HH–C–451*a*, Class C. Firebrick shall be laid by dipping each brick in a soft mixture of fire clay and water and then rubbing the brick into place. Brick shall be laid flat in regular bond and the face joints wiped clean.

93. *Brick for interior paving* shall be either vitrified common brick selected for uniformity of shape and size, or plain wire-cut paving brick, 2½ by 4 by 8½ inches in size, complying with Federal Specification SS–B–671*a*. The brick shall be laid on edge in a dry mixture of 1 part Portland cement and four parts sand spread ½ inch thick, then tamped to a uniform bearing and level surface and grouted with 1 to 2 cement and sand until all the joints are filled. The surface shall be wiped clean and the joints finished smooth.

54. *Dimensions.*—Figured thicknesses of walls are based on standard size units. For spacing of face brick courses and for jointing of pattern work or special details, see drawings. Courses of common brickwork shall be so spaced as to level off flush with the face work at all bonding courses and at joints with metal ties. Joints in common brickwork should not exceed ⅝ inch in width.

96. *Anchors, ties, etc.*—Ties for brick and tile work shall be of wire or sheet metal so looped or corrugated as to form a secure bond and shall be zinc-coated. Wire shall be at least No. 11 gage (.12 inch) and sheet metal shall be at least ⅞ inch wide and not lighter than 22 U. S. Standard gage. Ties of wire netting shall be strips at least 8 inches long of ½ inch mesh No. 16 gage wire fabric. Ties shall extend at least 4 inches into masonry backing and to within ½ inch of the face of the facing or furring.

98. The anchorage for masonry facing or furring materials to concrete shall consist of an anchor and a metal slot or insert. The slot or insert shall be built into the concrete at the proper location to receive the anchor and, when so built in, shall develop the full strength of the anchor without breaking or pulling loose from either the anchor or the concrete. Anchors shall be hooked, looped or crimped for bond, shall be spaced not over 2 feet apart horizontally and shall be placed on every fourth and sixth course of brickwork, every third course of wall units and every alternate course of structural tiles. Wire inserts shall be not less than 9 gage (.145 inch) and wire anchors not less than 11 gage (.12 inch). Flats shall be not less than 16 gage by 1 inch. Heavier anchors shall be provided where so indicated on the drawings. All metal shall be zinc-coated.

101. *Cleaning.*—On completion of the work all face brick shall be cleaned down, removing excess mortar, mortar stains, etc. If acid is used, it shall be muriatic (hydrochloric) and not stronger than one volume of the commercial acid to nine volumes of water. The brickwork shall be thoroughly wet before the acid solution is applied, hosed with water afterward and all acid removed. All work connecting with the face brick shall be carefully and adequately protected against contact with the acid solution.

TILE WORK, GLAZED WALL UNITS

2. Glazed or enameled brick shall comply with this specification.

3. Wall units shall be solid or may be cored up to 40 percent of the gross sectional area. When required for the wainscoting in workrooms or in similar places exposed to continuous heavy impact, cored wall units that are located less than 4½ feet above the floor level shall have a net sectional area of not less than 75 percent of the gross sectional area.

4. For size and arrangment of wall units, see drawings. Sizes indicated are nominal sizes, subject to the tolerances specified. Field units shall be of the bond thickness indicated or specified, and no field unit shall be less than 1¾ inches thick. Wall finish shall extend into the reveals of openings unless otherwise indicated.

5. Where glazed or enameled brick are indicated, they shall be of standard brick dimensions.

6. Where glazed surfaces are indicated for both faces of a wall or partition, two or more units shall comprise the thickness of the wall with an approved bonding course spaced not more than every fourth course for units five or six inches high, nor more than every third course for units eight inches high. The bonding of 4-inch walls or partitions shall be made with double-faced, through-bearing units as alternate units in every second course, or comprising the whole of every fourth course. Where through-bearing units are used, they shall be gaged for thickness in setting so as to produce a flush surface on both sides of wall or partition.

8. The glazed units shall be made from selected clays and fusible minerals, carefully proportioned and mixed and thoroughly burned to produce a strong homogeneous body that will give a sharp metallic bell-like ring when struck.

The finished units shall be straight and accurate with full, clean-cut corners and edges.

9. Any pieces that are over- or under-burned, warped, or discolored, or that have cracks or spalls on exposed surfaces or that show a tendency to craze or peel will be rejected.

13. *Salt glazed units.*—The surfaces that will be exposed when the units are laid in place shall have the colors and finish produced during the process of burning by introducing salt or other coloring agents into the fire.

14. When colors are required for incidental trim such as base, cap, etc., that cannot be produced from the natural clay, ceramic slips shall be used and the finish produced in burning, or ceramic glazed units shall be substituted.

15. Salt glazes shall have a smooth, gloss finish and shall meet the following test for acid resistance: A portion of the finished surface of one or more units shall be submerged in a 10 percent solution of hydrochloric acid for three hours, then cleaned and examined. Neither the color nor the luster of the finish shall be altered by this treatment. The Government reserves the right to waive the acid test.

16. Salt glazed units shall not be substituted for ceramic glazed or enameled units.

17. *Ceramic glazed units.*—Textures and finishes shall be obtained by the use of ceramic mixtures applied to the faces of the wall units and made permanent by burning. The finish shall cover all exposed surfaces perfectly. Colors shall be uniform and without marked variation in general tone, except where blended or mottled effects are specified. The wall units shall have a smooth body surface prior to the application of the finish.

18. The terms used in describing the colors and finishes desired under this specification are defined as follows:

    a. Ceramic finish designates the surface and color which is applied by ceramic processes of coating, glazing, burning, etc.

    b. Gloss, satin, mat, and porcelain designate varying degrees of luster and light reflection, accompanied with slight variations in surface texture.

    Gloss has a bright luster and strong light reflection.

    Satin has a soft luster and medium light reflection.

    Mat has a dull luster and weak light reflection.

    Porcelain has practically no luster and no noticeable light reflection.

    c. Smooth ceramic finish shall be smooth to touch except for the slight waviness characteristic of ceramic glazes. It shall be either gloss, satin, mat, or porcelain as indicated.

    d. Speckled ceramic finish shall be obtained by introducing suitable fusible minerals into the ceramic glaze. It shall be fine, medium or coarse speckled as indicated and of the body color noted. The texture of this finish has a variable degree of roughness according to the size and number of speckles. It shall be mat or porcelain as indicated.

    e. Stipple or ripple ceramic finish shall be so applied as to produce a stippled or rippled effect and shall be either satin, mat, or porcelain as indicated.

    f. Mottled ceramic finish is a conglomerate mixture of two or more colors applied through a group of separate nozzles in the same operation to produce a mottled effect and shall be either satin, mat, or porcelain as indicated.

    g. Enameled ceramic finish shall be smooth, with a brilliant gloss and mirror-like reflection.

24. *Anchors.*—Where bond courses are not indicated or specified, every alternate unit in every second course of units 8 inches high, in every third course of units 5 or 6 inches high, and every sixth course of standard brick-size units, shall be anchored to the backing.

25. Anchors shall be of wire or sheet metal so looped or corrugated as to form a secure bond and shall be zinc-coated. Wire shall be at least No. 11 gage (.12 inch) and sheet metal shall be at least ⅞ inch wide and not lighter than 22 United States Standard gauge; anchors shall extend at least 4 inches into the masonry backing and to within ½ inch of the face of the ashlar unit.

26. *Setting.*—Wall units shall be cleaned, then sponged or sprayed with clean water just before setting to reduce suction. Each piece shall be set level and true to line in a full bed of plastic mortar and tapped home to a full, even bearing. All spaces at backs and cross joints from front to back and top to bottom shall be filled solid with setting mortar, leaving no voids. Faces of wall units shall be kept free of mortar.

27. The units shall be laid in regular bond, unless otherwise indicated.

28. All cutting on the job shall be done with a motor-driven carborundum saw to assure clean, straight joints.

29. Face joints shall be not less than $^3/_{16}$ inch nor more than $^5/_{16}$ or ¼ inch wide and as nearly uniform as practicable. Face joints shall be smooth and slightly concave in profile.

30. If Class C mortar is used for setting, face joints shall be raked out ½ inch deep at the time of setting, leaving clean surfaces for pointing with Class D mortar. Pointing shall be done as soon as the setting mortar is hard enough to safely permit it. Joints shall be brushed clean, wet thoroughly and pointed solid, finishing with a metal jointing tool.

31. If Class D mortar is used for setting, the joints shall be filled and jointed as the work progresses. The mortar in the face joints shall be compacted and finished to uniformly straight and true lines and surfaces with a metal jointing tool.

32. *Cleaning.*—Upon completion of the work, all surfaces of glazed wall units shall be cleaned down using soap powder boiled in clean water and applied with stiff fiber brushes and then rinsing with clean water. Hard lumps of mortar may be removed by using sharpened wood paddles. Metal cleaning tools or brushes or acid solutions shall not be used.

77. *Setting tile.*—Structural tile shall be set plumb and true to line in regular bond and properly joined to other connecting work. No open ends shall show on either face of the wall or partition or at returns. Tile shall be set in full beds of mortar and all joints filled, unless otherwise specified. Face joints of interior work that will not be covered by other finish shall be neatly struck.

78. The use of broken tile will not be permitted. Split tile shall not be used, except that tile furring against masonry or concrete may be split from standard tile of the right thickness which have been properly scored for that purpose at the time of manufacture. Closure tile shall be stock specials, or if cut from standard tile, shall be whole units acceptable to the Construction Engineer. All other spaces occurring in the work that are not large enough for full tile shall be filled with brick properly bonded.

79. Where load-bearing tile are indicated in exterior walls, the break in the horizontal joints of such tile work shall be left open. All joints on the interior face of load-bearing tile in exterior walls shall be finished with a metal jointing tool as soon as possible after the mortar has attained its initial set so as to compact the mortar in the joint, forcing it tight against

the tile and closing all cracks and crevices. This jointing shall be done whether or not the tile will be exposed in the finished work.

80. Partition tile that interlock the full height of the tile at vertical joints may be set with mortar in the bed joint only, provided the tile are set close to get the full benefit of the interlocking feature. Mortar shall not be omitted from the vertical joints of such tile that are used for column covering, nor where such tile without scoring are exposed in the finished work.

81. Partitions, furring, fireproofing, etc., shall start on the structural slabs or footings. They shall be bonded each course at corners and intersections, and vertical joints shall be broken at least 3 inches. Tile work terminating against beam soffits, floor slabs, and structural ceilings shall be wedged tight and the joint filled with mortar. Partitions and furring shall extend at least 2 inches above the ceiling level of suspended ceilings. It is not the intention that tile work shall extend above the lath that contacts the bottom of concrete joist construction.

82. Partitions that abut unfurred walls shall be bonded or anchored thereto once every 4 feet in height. Double partitions of tile less than 4 inches thick shall have a through block every 10 square feet of area. Partitions or furring inclosing pipe spaces shall be built after the pipes are in place and tested to the satisfaction of the Construction Engineer.

83. Tile for covering steel columns shall be at least 3 inches thick. The tile shall be set ½ inch away from the steel and all spaces between the tile and the column shall be filled solid with mortar and tile as each course is laid. Column covering shall not be reduced or omitted at abutting vent pipe spaces.

84. Suitable recesses shall be provided for built-in radiators, cabinets, junction boxes, etc. The exact size and location of recesses shall be as required by the mechanical equipment. Metal work required shall be built in as the work progresses.

85. Tile furring against masonry (except where waterproofing occurs on the inside) shall be anchored thereto with ties of wire netting or U-shaped wire spaced about 2 feet apart in horizontal joints of the tile. Where tile furring occurs over waterproofing, 3-inch partition tile shall be used for furring. No ties or anchors shall be used through waterproofing.

86. Column covering and isolated piers of structural tile and pipe furring at free-standing columns shall be reinforced with ties of wire netting the full width of the tile laid in each horizontal joint and lapped at corners.

87. Square head openings in load-bearing tile without steel lintels shall have tile lintels filled with Class A concrete and reinforced with steel rods; the minimum reinforcement to be ½ inch diameter rods in the top and bottom cells, unless otherwise shown.

88. Where load-bearing tile are set with cells vertical, flat slab tile 1 inch thick shall be set to provide bearings for wood framing. Sections of walls, piers, etc., so indicated shall be filled solid with concrete to receive and distribute the loads from steel framing.

89. *Smoke flues* that are 18 inches and less in any inside cross dimension shall have tile flue lining. Larger flues shall be lined with either tile flue lining or with firebrick in the lower portion and common brick above as specified. Tile lining shall extend from 1 foot below the inlet to 2 inches above the top of the flue. Firebrick lining shall start at least 1 foot below the inlet and extend to a level 15 feet above same or more if so indicated; the lining above the firebrick to be Class H common brick. Brick lining shall be included in the thickness of the wall as shown.

90. Where the shape of the tile flue lining is shown on the plans, any other shape of tile flue lining may be used, at the option of the contractor, provided the rated capacity and effective area of the one used are equal to or greater than those of the one shown, and provided the substitution does not require a change in the dimensions of the chimney.

91. *Tile flue lining* shall be sound, hard-burned, unwarped and free from cracks and spalls. Lining shall have inlet openings of the proper size formed before burning, or the inlet section shall be of firebrick. Inlets shall be fitted with terra cotta thimbles unless otherwise specified. Lining shall be set straight and plumb and with close, smooth joints in Class B mortar

U. S. Department of Agriculture
(From Typical Specifications)

BRICKWORK

2. *Brick*—

a. All brickwork, unless otherwise specified, shall be built of approved quality, well-burned, common clay or shale bricks, reasonably uniform in size and shape, and without excessive laminations, checks, spalls or warpings, and shall meet all requirements for hard brick of Federal Specifications No. SS–B–656, Grade H. The exposed exterior brick shall be of approved range of buff colors. All brick shall be piled as delivered and protected from the weather.

b. Bricks which are to be laid flat or in projecting courses where any of the top or bottom faces will be exposed to view shall be made without holes extending through or depressions in the face, and shall have a finish on top and bottom faces similar to the color and texture of the sides and ends of approved brick sample.

5. *Laying*—

a. Brickwork shall be built plumb and true to line and shall be bonded thoroughly.

b. Unless otherwise shown, all exterior face brickwork shall be laid five courses running bond and every sixth course alternate header and stretcher.

c. Bricks for facework shall be laid out dry on foundation wall before starting laying and the bond shall be adjusted to openings, corners, etc. Pieces of less than one-half brick shall not be used in exposed work at corners or jambs. Where necessary to avoid use of small pieces, stretcher courses shall be started with three-quarter brick.

d. All head joints in facework shall line vertically throughout and individual head joints shall be symmetrical with bricks above and below.

e. Where through bond cannot be used, facing brick shall be anchored to columns, spandrel beams, etc., with metal ties or anchors as specified under Section 16C. In all other places brick shall be bonded to backing with through headers.

h. Boiler flue shall be lined throughout its entire height and incinerator flue to fourth floor elevation +33.0, with fire clay flue lining, having full dimensions as indicated on the drawings and having proper size breeching thimbles and door openings. Flue lining shall be built in ahead of the adjacent brickwork, and all joints in the fire clay lining and between lining and brick around same shall be solidly filled with mortar.

i. Brickwork on unfinished work shall be raked back. Toothing will be permitted only where absolutely necessary.

j. Before connecting with work previously set, all loose bricks and mortar shall be removed and work in place shall be thoroughly cleaned and wet.

k. Top of unfinished walls shall be kept covered and protected at all times except when brick are actually being laid.

l. Brickwork shall be properly protected from frost. Brick shall not be laid in freezing weather except by special permission of the superintendent, with the materials properly heated to prevent freezing, and at the contractor's own responsibility. If mortar becomes frozen the joints shall be raked out on face then refilled and painted later.

m. All metal anchors, straps, ties, metal wall plugs, bucks, louvres, vents, sleeves, etc., required for this or other branches of work shall be built in place in approved manner. Flashing and sheet metal work, where required, shall be built in as indicated.

n. Incinerator walls shall be built and incinerator grates, doors, etc., shall be built in according to equipment manufacturers' and Fire Underwriters' standard details and specifications.

o. All joints in brickwork, the space between facing brickwork and back-up material, and the space between backing brickwork and stone or other facing material shall be completely filled with mortar.

p. Joints in facing brickwork shall not exceed ½ inch in width and shall be uniform throughout. In exterior facing brickwork joints shall be finished, after mortar has begun to harden with a concave tooled joint, applying sufficient pressure to compact mortar and provide a water- and weather-tight joint. Where plaster or cement mortar is to be applied directly to the brickwork, the brick shall be laid with slack joints or the joints shall be raked out ½ inch deep, while the mortar is fresh, to furnish key. Joints in other brickwork shall be weather struck.

6. *Cleaning*—

On completion, brickwork shall be neatly pointed. All exterior exposed brick shall be washed with a 10 percent muriatic acid mixture and rinsed thoroughly with clean water, leaving brickwork in perfect condition. All other work that might be damaged by the acid shall be protected during the cleaning.

HOLLOW BUILDING TILE

6. *Setting*—

a. All walls, partitions, and furring shall be of the thickness shown, built straight and plumb. All beds and joints shall be completely filled with mortar. All joints which will not be covered with plaster under this contract and joints inside vent ducts, shall be smooth-cut flush joints.

b. Tile or unit shall be laid with a lap or bond of at least 4 inches. Partitions which abut other partitions shall be bonded every course. At external corners, the partitions shall be bonded by overlapping alternate courses, or by anchors built in with each course. Partitions which abut masonry walls, columns, etc., shall be anchored to same with strap anchors specified elsewhere, located every third joint in height.

c. Where brick jambs are required for openings, radiator recesses, brick piers, arches, etc., the tile or units shall be toothed or bonded into brickwork at least 4 inches. Metal ties shall not be used for bonding in these cases.

GLAZED WALL UNITS

3. *Setting*—

a. All walls, partitions and furring shall be of the thickness shown, built straight and plumb. All beds and joints shall be completely filled with mortar. All joints shall be smooth cut flush and shall be approximately ¼ inch wide.

b. All units shall be laid with a lap or bond of one-half unit unless otherwise detailed. Partitions which abut other partitions shall be bonded every course. Partitions which abut masonry walls, columns, etc., shall be anchored to same with anchors, specified elsewhere, located every third joint in height.

c. Unless otherwise required by drawings, partitions shall terminate under fireproof beams or slabs tightly wedged or anchored to beams or slabs and the joint filled from both sides with mortar.

d. Where anchorage into walls or partitions is required for brackets, etc., the voids in the units shall be solidly packed as units are set.

e. Unless otherwise indicated on plans, openings in walls and partitions shall be spanned with lintels of units with voids filled with concrete reinforced with not less than two ⅝ inch rods.

f. The contractor shall set or build into all masonry walls as the work progresses, all required anchors, bucks and tires; also approved metal wall plugs where required for securing wood grounds, furring, finish, etc.; also sleeves for pipe lines through walls, all to be furnished by others.

g. All necessary cutting, fitting, and repairing of concrete unit work in connection with the work of other trades shall be done in the best manner, as well as building chases, recesses or shafts for pipes, ducts, and conduits where required for heating, plumbing, and electrical work.

h. No broken units which would in any way be detrimental to the wall will be allowed.

4. *Cleaning*—

Before completion of the building all exposed surfaces shall be completely cleaned with abrasive soap and water using stiff fiber brushes. If necessary a 10 percent solution of muriatic acid in water may be used if satisfactory results cannot be obtained with soap.

Navy Department
Bureau of Yards and Docks
(From Standard Specifications)

BRICK AND HOLLOW TILE WORK

08. *Workmanship.*—All beds on which brick and tile are to be laid shall be cleaned and wetted properly, and, unless directed otherwise, all brick and hollow tile shall be wetted thoroughly before being laid. All tile shall be set in full beds, with vertical joints completely buttered or filled. All joints between brick shall be filled completely with fresh mortar and shall have a minimum and maximum thickness of ⅜ inch and ½ inch, respectively. Exposed joints shall be practically uniform in width. Bed joints shall be full, flat, and of uniform thickness; they shall not be furrowed. Cross joints shall be obtained by applying a full bed of mortar on the entire end of the stretcher or on the entire edge of the header, as the case requires, and then shoving the brick tightly against the brick already in place; the practice of buttering at the corners of brick and then throwing mortar or

scrapings into the empty joints will not be permitted. Wall joints shall be obtained by applying a full coat of mortar on the edges of each course of stretches and on the ends of each course of headers, against which the brick shall be shoved. Before laying a brick or part thereof to close the space between two other brick already laid, fresh mortar shall be applied against the end of each of these brick and on the flat brick, and then the closure brick shall be rocked into place. Dry or butt joints will not be permitted. Grouting shall be done only where directed. Brick and hollow tile work shall be built level, square, plumb, and true; bats shall be used only for closures. When directed, tops of exposed walls shall be covered with watertight material while work thereon is not in progress. All drilling, cutting, and fitting of brick and tile work, required by other work and for making good after such work, shall be done as necessary. Lintels, bolts, anchors, plugs, ties, and other metal work specified elsewhere herein and occurring in connection with brick and/or tile work shall, where practicable, be placed in position as the work progresses. Chases of approved dimensions for plumbing and heating pipes or for other purposes shall be provided in walls where necessary. Hollow tile shall be laid with the horizontal joints uniformly level and the vertical joints staggered. Joints shall be of reasonably uniform thicknesses. Tile partitions and walls shall be wedged at the top and shall be bonded or anchored to each other and to walls and columns. Non-load-bearing hollow tile may be laid with cells horizontal or vertical at the option of the contractor. Where anchors, bolts, and other ties, built in as the work progresses, occur within the cells of tiles, such tiles shall be filled with 1 to 2 to 4 concrete or 1 to 4 cement mortar.

09. *Lintels* for openings in hollow tile work, not shown otherwise, shall be formed of hollow tile filled solid with 1 to 2 to 4 concrete or 1 to 4 cement mortar, with two ⅝-inch round deformed reinforcing rods. They shall be built on the ground and allowed to set at least six days before being moved. The lintels shall be straight and true and, where practicable, shall have at least 8 inches bearing at each end.

10. *Cleaning.*—On completion, the brick and hollow tile work shall be pointed where necessary. All brick work exposed in the finished work shall be washed with a suitable solution of muriatic acid and rinsed thoroughly with clean water; other work that might be damaged by the acid shall be protected during the cleaning. All work stained or discolored during the process of cleaning shall be replaced by the contractor at his expense. (Note.—For light-colored brick, specify scrubbing with warm water and soap in lieu of acid cleaning.)

War Department

(From Standard Specifications)

BRICK, BUILDING TILE AND STRUCTURAL UNITS

4. *Mortar.*—Contractor shall have the option of using either of the following for masonry work not otherwise specified:

a. Portland cement mortar:	*Masonry cement mortar:*
1 part of portland cement.	1 part masonry cement.
1 part lime putty.	3 parts sand.
6 parts sand.	

One bag of cement weighing not less than 94 pounds shall be considered as 1 cubic foot.

f. Mortar for firebrick shall be composed of fireclay mixed with water to the proper consistency.

Unless otherwise approved by the C. Q. M., all jobs requiring 1,000 or more cubic feet of masonry shall have the materials mixed in a batch mechanical mixer. The actual mixing time shall be not less than two minutes.

8. *Laying brick.*—Brickwork shall be built plumb and true to lines with courses level. Each course shall be laid as a through course.

Walls shall be bonded with whole headers every sixth course, unless otherwise noted or specified.

Brick shall be shoved into place (not laid) in a full bed of mortar. All joints including joint between face brick and backup in brickwork shall be completely filled with mortar. This requirement is important and will be rigidly enforced. Excess mortar shall not be cut off in a manner that will tend to pull mortar from the contiguous brick surfaces. Brickwork built against concrete or metal work shall have the intervening back joint slushed or grouted full as each course is laid. Particular care shall be exercised to select only hard, well-burned brick for use in the first six courses of exterior brickwork above and adjacent to grade line.

a. Face work.—Brick courses shall be accurately spaced and laid out with a story rod. The bond of all face brick shall be plumb, laid out and adjusted so that no course will terminate at a corner or opening with a piece less than one-half brick in size. Vertical joints, in general, shall be slightly thinner than the horizontal joints.

Face brick shall be left free from mortar smears, dirt or stains.

d. Joints.—Face brickwork shall be laid up in natural color mortar with joints—flush
concave
convex
weathered
raked-back (specify depth—⅜ inch, ½ inch, etc.)

Except where otherwise specified or noted, mortar joints shall be approximately ½ inch wide.

All joints shall be formed with suitable tools.

Tooling of face joints shall be done in a manner to squeeze mortar back into the joints. No tooling shall be done until after mortar has taken its initial set.

Joints in unexposed work shall be flush, except as hereafter specified.

Joints in all rough exposed interior brickwork and surfaces to be dampproofed or waterproofed shall be flush.

Joints in brick surfaces to which plaster or stucco is to be applied shall be raked out ½ inch.

e. Chimneys shall be built of brick and, unless otherwise shown, shall be lined with terra-cotta flue lining which shall extend from one foot below smoke inlet to full height of flue and above chimney cap as shown.

e–1. *Firebrick.*—Chimneys shall be lined from 3′–0″ below smoke inlet to a height of — with firebrick laid in fireclay mortar.

e–2. *Fireplaces.*—Smoke chambers above fireplaces shall be built to present a reasonably even surface free from all rough projections.

10. *Laying building tile.*—Tile work shall be built plumb to lines, laid in full beds of mortar, with vertical joints breaking approximately to the middle of the course below. Each course of tile shall be properly bonded at corners and intersections and be either bonded into or anchored to other masonry.

Tile shall be built with the cells horizontal. Where vertical pipes or conduits occur, cells may be vertical. No cells shall be left open in wall surfaces.

Tile work terminating against the soffits of beams or slabs, etc., shall be wedged tight and have joints slushed full of mortar.

Jamb tile shall be of the shapes and sizes required to properly bond with the wall tile and shall be built in where shown or required.

Build in sections of brickwork where required for the securing of plumbing and other fixtures and wherever required to fill out corners, gable slopes, etc.

Tile partitions not otherwise shown shall be 4 inches thick.

Tile partitions along corridors, and around elevator and pipe shafts and similar situations shall continue from floor slab to ceiling slab. Tile partitions between or around rooms having suspended ceilings may stop at suspended ceiling level unless shown otherwise on the drawings.

Walls, columns, etc. shall be furred with tile as shown.

Tile around ducts and pipe enclosures shall not be bonded to other masonry but shall be anchored thereto with metal ties. Interior channel spaces of columns shall be filled with masonry using the shapes required for the purpose.

11. *Laying structural units.*—Structural units shall be installed as furring and partitions where indicated or specified. Units shall be built plumb to lines and laid in full beds of mortar.

Vertical joints shall break to middle of course below and all joints filled with mortar. Units shall be properly bonded at corners, and be bonded or anchored to other masonry.

Mortar joints shall be of uniform width, tooled slightly concave.

No units having chipped edges or the glaze spalled from face shall be used.

Wall units shall extend from floor to ceiling.

Wainscots shall extend to heights shown.

Cutting of units where necessary on the job, shall be done with a power saw having a carborundum or other suitable blade, to insure clean straight joints throughout the work. Cut units as required to build in all electrical outlets in a neat and approved manner.

Walls with two finished faces shall finish to the required lines on both sides and when constructed of two facing units shall be properly bonded or mechanically anchored together not over 2 feet horizontally and not over 1 foot 6 inches vertically.

Veterans' Administration
(From Typical Specifications)

BRICKWORK

4. *Bricklaying, etc.*—

a. Brickwork shall be built plumb and to a line. Brick shall be laid in a full bed of mortar with shoved joints and with each course completely flushed with mortar. All vertical and horizontal joints shall be completely filled with mortar. Facing brick shall be laid in bond with full bond headers in every sixth course. * * * Where new facing brickwork joins onto existing buildings, the center of the joints in new work shall coincide with the center of joints of existing work. Mortar for facing brickwork shall match the color of corresponding mortar in existing buildings. Where through bonding is not possible, the brick shall be bonded to the masonry walls, beams, etc., by approved metal ties. The bond of all facing brick shall be maintained plumb and the joints

shall be of practically uniform width throughout. Exterior brickwork shall be laid out with uniformity regarding openings and breaks in walls so that the brick and joints on each side of the center line of each opening, etc., shall be similar. No piece smaller than a half brick shall be used at any angle or jamb. Joints between facing brick and back-up tile or brick shall be completely filled with mortar.

b. Where hollow tile or concrete unit backing is used, the backing shall be placed first to the height of the header course and shall then be heavily coated or parged with not less than ½ inch of mortar. Facing brick shall then be laid in front of this backing.

c. Where brick backing is used the facing brick may be laid up first to header height and parged on back with not less than ½ inch of mortar. Back-up brick shall then be placed.

d. Parging shall be carefully done and especial care shall be taken at header courses so a break will not occur between parging and header bed. Parging shall be continuous over masonry, columns, spandrel beams, etc.

e. Where it is difficult to parge the masonry as specified, the contractor may provide, in lieu of such parging, a 2-ounce copper flashing reinforced with waterproof fabric or craft paper as specified for window sills under Section 21C, "Miscellaneous Roofing and Sheet Metal," providing details are submitted and approval obtained for such work.

f. Where plaster is to be applied directly to the brickwork, the brick shall be laid with slack joints or the joints shall be raked out while the mortar is fresh to furnish key. Interior facing brickwork shall have neatly troweled flush joints.

g. Brick backing for stonework shall be carried up so as to be not more than two face courses below the top of the stone at any stage of the work.

h. All brickwork shall be thoroughly wet, except in freezing weather. Before connecting new work with existing work or with work previously set, sweep clean and thoroughly wet the work in place. Care must be taken that the tops of all unfinished walls are properly covered or protected against weather, etc.

i. Brickwork shall be properly protected from frost, or if mortar becomes frozen, the joints shall be raked out on face as the work progresses, then refilled and pointed later. No brick shall be laid in freezing weather, except by special permission of the superintendent, and in no case without taking all possible precaution against damage and at the contractor's own responsibility.

j. Build into place in approved manner, all metal anchors, straps, ties, blocks, bucks, frames, vents, sleeves, etc., as may be required for this or other branches of the work.

k. All flashings in connection with brickwork shall be built in as indicated on the drawings and specified elsewhere under Section 21C, "Miscellaneous Roofing and Sheet Metal."

7. *Brick Floors.*—

a. Brick platforms, where shown on drawings, shall be selected common brick as approved for facing, laid as indicated, and shall drain free from puddles.

b. Brick shall be bedded in the mortar specified, leveled or graded as indicated, and all joints shall be thoroughly filled with grout. Before any grout has set on the surface of the bricks, surplus grout shall be thoroughly removed and all brick left clean and unstained.

8. *Chimneys.*—

a. Chimneys shall be built of size and design shown, plumb and to line and laid in mortar with shoved joints, and each course completely flushed with mortar. Chimneys shall be of brick above roof matching exterior facing brick.

b. The tops of chimneys shall be as shown on drawings.

HOLLOW BUILDING TILE

(From Standard Specifications)

4. *Setting.*—

a. All walls, partitions, and furring shall be of the thickness indicated, built straight and plumb. All beds and joints shall be completely filled with mortar and face joints pointed. All joints which are not to be covered with plaster under this contract, and joints of all smooth-faced tile shall be smooth cut, flush joints and all such walls left in a neat and clean condition.

b. Tile back-up in exterior walls shall be laid up first, header high, and parged with one-half inch of mortar; then the face brick laid to it as specified in Section 5C, "Brickwork". Where back-up is more than one tile in thickness, tile shall be bonded transversely by overlapping courses at line of brick headers.

c. All tile shall be laid with a lap or bond of at least 4 inches. Partitions which abut other partitions shall be bonded every course. At external corners the partitions shall be bonded by overlapping alternate courses or by anchors built in with each course. Partitions which abut masonry walls and columns shall be anchored to same with anchors as hereinafter specified.

d. Where brick jambs are required for openings, radiator recesses, etc., the tile shall be toothed or bonded into brickwork at least 4 inches. No metal ties shall be used for bonding in these cases.

e. Partitions shall terminate under fireproof beams or slabs in rooms where suspended ceilings are not required and around rooms or corridors where accoustical treatment of the metal suspension system type, or a sprayed on metal lath type, is used on ceilings. If plaster applied systems of accoustical treatment are used, the partitions need only extend to the 4-inch limit specified. Partitions shall be tightly wedged or anchored to beams or slabs and the joint filled from both sides with mortar. In all other places, the partitions shall extend at least 4 inches above the suspended ceilings or furring, except as otherwise specifically shown or specified.

f. Where hollow tile partitions enclose rooms, corridors, etc., having accoustical treatment, special care shall be taken to fill all joints, cracks, holes, etc., with mortar in portion of partitions extending from the ceiling to structure above.

g. In buildings where partitions occur under steel trusses, such partitions shall be tightly wedged or anchored in place, and adjacent partitions shall terminate on a line with top level with the partitions terminating under trusses or as otherwise indicated.

h. Partitions having lavatories or other plumbing fixtures secured to the tile and located back to back (or approximately so) and all partitions so noted shall be built of 6-inch tile.

i. Brickwork shall be built in partitions and walls in places where a full tile cannot be used. Brickwork shall also be installed in lieu of hollow tile, to provide anchorage as directed by superintendent.

j. Partition tile may be laid horizontal but all load-bearing tile shall be laid with the cells vertical, except where such tile is specifically designed and manufactured for laying with horizontal cells.

k. Defective units which would in any way be detrimental to the wall, will not be allowed.

l. All necessary cutting, fitting, and repairing of hollow tile work in connection with the work of other trades; building chases, recesses or shafts for pipes, ducts, and conduits, where required for heating, plumbing, and electrical work, and recesses for radiators, fire hose cabinets, control cabinets, etc., shall be done in best manner.

5. *Lintels.*—The tile partition above openings not exceeding 4 feet 6 inches in clear span may be supported on metal door frames, etc. Openings in exterior walls not exceeding 4 feet 6 inches clear span shall be spanned with tile reinforced with proper steel rods in cells and filled solidly with Type "B" concrete unless otherwise indicated. Openings over 4 feet 6 inches in clear span shall be provided with lintels of Type "B" concrete, reinforced with not less than two ⅝-inch diameter rods or with steel lintels as shown or directed.

6. *Wall plugs, etc.*—The contractor shall set or build into all masonry walls as the work progresses, all required anchors, bucks, ties, etc., also approved metal wall plugs where required for securing wood grounds, furring, standing finish, etc., also sleeves for pipe lines through walls, furnished and located by contractor for Heating, Plumbing, Electrical Work, Etc.

NOTE.—Veterans Administration allows hollow concrete units (optional) in lieu of hollow building tile.

Appendix D.—BIBLIOGRAPHY OF PUBLICATIONS AND ARTICLES ON BRICKLAYING

Adams, Henry. Building construction. London, Cassell & Co., Ltd., 1907.

Allen, John Parnell. Practical building construction. 584 pp. 6th ed. rev. New York, Van Nostrand Co., 1924.

Brick bond and its application. A handbook for students and a reference for persons engaged in building.

Andrews, Andrew I.; Bole, George A.; *and* **Withrow, James R.** The making of dolomite brick and a study of their properties. 51 pp. illustrated. Bulletin No. 31 of the Engineering Experiment Station. Columbus, Ohio, Ohio State University, 1925.

A small pamphlet on an investigation which deals with the making and the properties of dolomite brick.

Ansell, H., *and* **Searle, A. B.** Burned glazed ware. 269 pp. illustrated. British Clayworkers Manuals. London, H. G. Montgomery, 1929.

Architectural terra cotta. New York, Metropolitan Building, National Terra Cotta Society.

Arthur, William. New building estimator's handbook. 1018 pp. illustrated. 14th ed. rev. and enl. New York, Scientific Book Corporation, 1926.

A handbook for architects, builders, contractors, appraisers, engineers, superintendents, and draftsmen.

Baker, Ira O. Construction and care of brick pavements. Bulletin No. 9. Urbana, Ill., University of Illinois, 1908.

Baker, Ira O. A treatise on masonry construction, 10th ed. New York, John Wiley & Sons, 1909.

Baker, Samuel, *and* **Williams, J. P. J.** Design of columns [and] masonry. 72, 29 pp. illustrated. Scranton, Pa., International Textbook Co., 1931.

Bergman, *Sir* Torbern Olof. The origin of chemistry. [Publisher.]
The origins and history, chemical analysis of mercury and muriatic acid and processes of burning brick.

Blair, M. W., *and* Orton, E., *Jr.* A study of the rattler test for paving brick. Columbus, Ohio, Ohio State University.

Bleininger, A. B. Effect of heat upon clays. Washington, D. C., U. S. Bureau of Standards, 1911. (Technologic papers.)
The effect of preliminary heating treatment upon the drying of clays.

Book of Standards. Part II, Nonmetallic materials. 1480 pp. illustrations and tables. Philadelphia, Pa., American Society for Testing Materials, 1936.
Specifications, methods of testing, definitions, and recommended standards relating to nonmetallic materials.

Boyd, David Knickerbacker, *and* White, Charles E. Common brickwork and architectural terra cotta. 70, 78 pp. illustrated. Prepared under supervision of William S. Lowndes. Scranton, Pa., International Textbook Co., 1932.

Bragg, J. G. Compressive strength of large brick piers. Washington, D. C., U. S. Government Printing Office, U. S. Bureau of Standards, 1918.

Brick and stonework. Mimeo. 28 pp. illustrated with drawings and diagrams Emergency Conservation Work, Project Training Series No. 5 May, 1937.

Brick church and parish house, The. Illustrations and diagrams. St. Louis, Mo., Hy Press Brick Co., 1915.
A collection of designs for churches and articles describing each plan.

Brick Engineering, Volumes I–III. Vol. I, Maj. L. B. Lent, Physical Properties of Brick and Brickwork, 92 pp. illustrated. 1929; Vol. II, Maj. L. B. Lent, Design and Construction of Brick Buildings, 126 pp. illustrated. 1931; Vol. III, Hugo Filippi, Reinforced Brick Masonry, Principles of Design and Construction, 240 pp. illustrated. 1933. Cleveland, Ohio, Common Brick Manufacturers Association of America.

Brick for the average man's home. Chicago, Ill., Common Brick Manufacturers Association, 1920.
Thirty-five designs for cottages, apartments, one and two-car garages. Illustrations, drawings, and specifications.

Brick houses. Chicago, Ill. Collected and published by American Face Brick Association, 1922.
Architectural designs of small houses submitted in competition by architects and draftsmen from 400 selected for merit.

Bricklayer, Mason, and Plasterer, Monthly. Washington, D. C., Bricklayers, Masons, and Plasterers International Union of America.

Bricklayers, Masons, and Plasterers, Wage Charts for Wage Arbitration. New York, Mason Builders Association, 1933.

Bricklaying—Choosing a Life Work series. Ottawa, F. A. Acland, 1928. Issued by Technical Education Branch, Department of Labour, Ottawa, Canada.
A small pamphlet presenting information regarding the place and importance of bricklaying, also the nature and requirements of the occupation.

Brick and Clay Record, monthly publication. Chicago, Ill., 59 E. Van Buren Street, Industrial Publications, Inc., publishers.

Bricklaying. St. Paul, Minn., Twin City Brick Co.
Illustrations, diagrams, and plans for 2-inch veneering of brick and clay roofing tiles.

Brickwork in Italy—compiled from the works of Carlo Rocctelli and Enrico Verdozzi. 296 pp. illustrations and colored plates. Chicago, Ill., American Face Brick Association, 1925.
A brief review from ancient to modern times with information of cultural as well as of architectural interest.

Briggs, H. L., *and* **Carver, William.** Practical bricklaying. Rev. and enl. ed. New York, McGraw Hill Co., 1924.
Instructions for the journeyman bricklayer.

Brown, A. E. Practical clayworking. London, The Clayworkers Press, 1936.
A descriptive treatise on the manufacture of brick and tiles by modern labor-saving plant and equipment.

Building Brick Association of America. A house of brick at moderate cost. Boston, Mass., Rogers & Manson Co., 1910.
A collection of 71 designs of 5-, 6-, and 7-room houses selected from 300 drawings in a competition.

Building Economy. Cleveland, Ohio, Common Brick Manufacturers Association of America.

Build with brick. Indianapolis, Ind., National Building Brick Bureau, 1917. Illustrations and plans.

Burke, M. D. Brick for street pavements. Robert Clarke & Co., 1892.
An account of tests made of brick and paving blocks, with a brief discussion of street pavements and the method of constructing them.

Carver, William. Brick, how to build and estimate. 5th ed. 56 illustrations, architectural plates, 30 tables. Cleveland, Ohio, Common Brick Manufacturers Association of America.
A manual of construction data on brickwork for architects, engineers, contractors, and builders for class use in educational and manual training schools.

Chapin, H. S. A revolution in building materials. 2d ed. 30 pp. illustrated. New York, Building Brick Association of America, 1911, Economy of brick construction.

Chatley, Herbert. The constitution of clay-mud. London, 1927. [Publisher]
A 15-page pamphlet on the composition of clay-mud.

Clay products encyclopedia. Chicago, Ill., Industrial Publications, Inc., 1922.
Information on every branch of the clay-products industry.

Coffin, Lewis A., *Jr.,* *and* **Holden, Arthur C.** Brick architecture of the colonial period in Maryland and Virginia. New York, Architectural Publishing Co., 1919.

Collin, L. P. Laboratory tests on structural assemblies of brick and tile. Ottawa, Canada. J. O. Patenaude I. S. O. Printer to the King, 1935.

Collis, Edgar L., *and* **Smith, Sidney.** Report on manufacture of silica bricks and other refractory materials used in furnaces with reference to effects of dust inhalation on workers. London, Darling & Sons, Printer, 1917.

Contemporary detail in common brick. 32 pl. Cleveland, Ohio, Common Brick Manufacturers Association of America.
Details of common brick for architects and designers showing contemporary brickwork practice. Illustrations of European work included.

Contract Documents for Small House Construction. Technical Bulletin No. 3. Washington, D. C., Federal Housing Administration. Rev. Feb. 1938.

Corkhill, Thomas. Brickwork, concrete and masonry. Illustrated. Toronto, London, Melbourne, Sir Isaac Pitman & Sons, 1930.
Complete work by practical brickwork specialist.

Cosgrove, J. J. Hollow tile construction. Illustrated. New York, Scientific Book Corporation, 1921.

Dancaster, Ernest A. Limes and cements; their manufacture, nature and use. Illustrated. New York, 29–35 West Thirty-second Street, D. Appleton & Co., 1916.
An elementary treatise.

Davis, Charles Thomas. A practical treatise on the manufacture of bricks, tiles, terra cotta, etc. 3d ed. Philadelphia, Pa., Henry Carey Baird & Co., 1895.

Davis, W. E. Quantities and quantity taking. 6th ed. Illustrated. New York, Isaac Pitman & Sons.

Dimelow, John. The brickmakers guide. 1873.

Distinctive Brick Homes. National Building Brick Bureau.
Illustrations and plans of brick homes. The foreword contains a discussion "Brick *vs.* Wood—A Comparison."

Dobson, Edward. Rudimentary treatise on the manufacture of bricks and tiles. 14th ed., thoroughly revised, rewritten, and enlarged by Alfred B. Searle. 234 pp. illustrated. London, Technical Press, 1936.

Emerson, William *and* **Gromort, Georges.** The use of brick in French architecture. New York, Architectural Publishing Co. Illustrations and designs.

English precedent for modern brickwork. Edited and published by the Architectural Forum, New York. 97 pp. Cleveland, Ohio, American Face Brick Association, 1924.
Plates and measured drawings of English Tudor and Georgian brickwork, with a few recent versions by American architects in the spirit of the old work.

Estimating masonry materials and labor for face brick construction. Chicago, Ill., American Face Brick Association.
Small pamphlet with tables and diagrams.

Fiske, J. Parker B. Cost of a house. 15 pp. illustrated with plans, diagrams, and tables. New York, Building Brick Association of America, 1911.
A comparison of brick, wood, cement, and hollow-block construction.

Flues and flue linings. 30 p. bulletin. Philadelphia, Pa., Eastern Clay Products Association, 1924.
Offered in the interest of restraining fire and combusion—gives complete information on linings with related data on chimneys and fireplaces.

Frost, William. The bonding of brickwork. Edited by F. E. Drury. 222 pp. illustrations and diagrams. Cambridge, England, 1933, and New York, Macmillan Co., 1934.

——— ———. Bricklaying for beginners. 120 pp. illustrations, outlines, and drawings. (Building Trades Series.) London, English Universities Press, 1935.

Gilbreth, Frank. Bricklaying system. London, M. C. Clark Publishing Co., 1909.

Gillespie, Curtis. Rumford fireplaces—how they are made. 200 pp. illustrated. New York, William T. Comstock, 1906.
Contains political, economic, and philosophical essays of Benjamin, Count of Rumford. Vol. I printed by Manning and Loring, Boston, for David West. Sold at Cornhill, Boston and Charliflore. A treatise on the building and repair of fireplaces for heating and cooking.

Gillingham, H. E. Some early bricklayers of Philadelphia. Pennsylvania Historical Society. 1929.

Glanville, W. H., *and* **Barnett, P. W.** Mechanical properties of brick and brickwork. London, His Majesty's Stationery Office, 1934.
Illustrated plans, tables, and diagrams, analysis of scientific research on building brick and brick materials.

Graham, Frank D., *and* **Emery, T. J.** Audel's Masons and Builders Guide. Illustrations. New York, Theo. Audel & Co., 1924.
A practical trade assistant on modern construction for bricklayers, stone masons, cement workers, plasterers, and tile setters.

Griffin, Henry R. Clay glazes and enamels. Indianapolis, Ind., T. A. Randall & Co., 1913.

Hambrecht, George. Wisconsin standard requirements for bricklayers. Chairman Industrial Commission for Bricklayers, 1918.

A 4-page leaflet showing the subject matter of the trade for bricklaying which the apprentice must know before he can receive the State diploma.

Hammond, Adam. Practical bricklaying. 14th ed. rev. 128 pp. London, C. I. Lockwood & Sons, 1930. In 6 sections.

Architectural drawings of cutting, setting, pointing, tiling, slating, plastering, geometry and mensuration.

Handbook of hollow building tile construction. Chicago, Ill., Conway Building, Hollow Building Tile Association, 1923.

Handbook of standardized glazed brick and tile. 27 pp. illustrated. Washington, D. C., Glazed Brick and Tile Institute, 1939.

Bulletin containing chart of standard shapes and finishes of glazed brick together with illustrations of exterior and interior use of the material.

Harvey, L. D. Practical arithmetic, 2 books. New York, American Book Co., C 1908–9.

Hasluck, Paul N., *ed.* Bricks and Brickmaking, London and New York. 1906.

A comprehensive treatise of brick and brickmaking taken from 21 volumes of the *Brick World.* The qualities of clays, brick earths, brick kilns, hand-manufactured brick and tiles. The making of roofing tiles, ridging, quarries, and coping.

Heart of the Home, The. 24 pp. illustrated. Washington, D. C., The Structural Clay Products Institute, 1939.

A discussion of the fireplace with drawings showing method of construction. Several pages devoted to method of constructing outdoor fireplaces.

Hodgson, Frederick, T., *and* **Brown, William N.** The builders' and contractors' guide to correct measurements. Illustrated. Chicago, Ill., 1006 South Michigan Avenue, Frederick J. Drake & Co., 1906.

Hodgson, Frederick T. Cyclopedia of bricklaying, stone masonry, concrete, stuccos, and plasters. Chicago, Ill., 1006 South Michigan Avenue, Frederick J. Drake & Co., 1920.

——— ———. Practical bricklaying self taught. Chicago, Ill., 1006 South Michigan Avenue, Frederick J. Drake & Co., 1908.

Instruction in all kinds of foundation bonding, arching, gaged work, dam coping, bridges, piers, chimneys, flues, fireplaces, plain and fancy courses.

——— ———. Twentieth century bricklayers' and masons' assistant. Chicago, Ill., 1006 South Michigan Avenue, F. J. Drake & Co., 1913.

Home competition drawings. Washington, D. C., Structural Clay Products Institute, 1939.

A series of five sets of drawings of small brick houses which were awarded prizes and honorable mentions in a contest open to architects, held 1939.

Home Fires, The. 48 pp. illustrated with line drawings. Chicago, Ill., American Face Brick Association, 1923.

Information on the proper construction of fireplaces and chimneys with designs of fireplace facings in brick. Appropriate inscriptions which may be used on fireplaces.

Home of Beauty, The. 6th ed. illustrated. Chicago, Ill., The American Face Brick Association, 1925.

A collection of 50 architectural designs for small houses, 5 and 6 rooms, submitted in competition by architects and architectural draftsmen and selected from 400 for their merit.

House of brick at moderate cost. Compiled and collected by the National Brick Building Association. Boston, Mass., Rogers & Manson, 1910.

The value of a brick house as an investment.

Howe, Malverd A., Masonry. 160 pp. illustrated. New York, John Wiley & Sons, 1915.

A short textbook on masonry construction, including descriptions of the materials used, their preparation and arrangement in structures.

Humphrey, Richard L. The fire-resistive properties of various building materials. Washington, D. C., U. S. Government Printing Office. Bulletin 370 of the U. S. Geological Survey.

Huntington, Whitney Clark. Building construction. 596 pp. illustrated. New York, John Wiley & Sons; London, Chapman & Hall, 1929.

Types of construction, materials and cost estimating.

Impervious Brick Masonry. St. Louis, Mo., Alton Brick Co., 1933.

Illustrations and diagrams.

International Correspondence School Staff. Elements of stone and brick masonry. (Bluebooks) 59, 30, 52 pp. illustrated. Scranton, Pa., International Textbook Co., 1930.

International library of technology. Scranton, Pa., International Textbook Co., 1923.

Volume describing common brickwork, face and ornamental brickwork, architectural terra cotta, hollow tile, and building stone.

Jaggard, Walter R. Brickwork and its construction. 318 pp. illustrated with line drawings. New York and London, Oxford University Press, 1929.

A textbook for all workers in brick. Practical and technical information not only for the craftsman but also for the architect and engineer.

Jervis, George J. *and* **Boyd, David Knickerbacker.** Face and ornamental brickwork [and] plastering. Section of Ornamental Brickwork by George J. Jervis. 90 pp. folder; illustrations and diagrams. Scranton, Pa., International Textbook Co., 1930.

Johnson, John B. The materials of construction. 6th ed. 865 pp. illustrated. Rewritten by M. O. Withey and James Ashton. Edited by F. E. Turneaure New York, John Wiley & Sons, 1925.

Kidder, Frank E. Building construction and superintendence, 3 pts. New York, 23 Warren Street, William T. Comstock Co., 1913–1916.

Kidder, Frank E. Architects' and builders' pocketbook ed. rewritten by T. Nolan. Illustrated. Part 3. New York, 432 Fourth Avenue, John Wiley Sons, 1921.

Kimball, Frank H. & Co. Specifications for the construction of vitrified-brick street pavements and vitrified-brick highways. Washington, D. C., National Paving Brick Manufacturers Association, 1914.

Laurie, A. P. Building materials. London. 1922.

Lloyd, Nathaniel. Building craftsmanship in brick and tile and in stone slates. 99 pp. London, Cambridge University Press, 1929.

Lloyd, Nathaniel. A history of English brickwork. Foreword by Sir Edwin L. Lutyens; new and abridged edition with preface by Leslie Mansfield, 77 pp. 140 pl. London, 43 Essex Street, H. G. Montgomery, 1935.

Examples and notes of the architectural use and manipulation of brick from medieval times to the end of the Georgian period.

Lovejoy, Ellis. Burning clay wares. Illustrated. Indiapanolis, Ind., T. A. Randall & Co., 1920.

Lovejoy, Ellis. Economics in brickyard construction. 72 pp. Indianapolis, Ind., T. A. Randall & Co., 1913.

Lutz, Edwin G. Practical drawing. New York, 597 Fifth Avenue, Charles Scribner's Sons, 1915.

A book for the student and the general reader with explanatory illustrations by the author.

MacDonald, A. J. Old colonial brick houses of New England. 55 pp. illustrated. Boston, Mass., Rogers and Manson, 1917.

A monograph series of subjects of architecture developed during the early days of the Republic.

Maginnus, Owen B. Bricklaying. New York, 23 Warren Street, William T. Comstock Co., 1906.

Mansbridge, Albert. Brick upon brick. 236 pp. illustrated. pl. London, J. M. Dent & Sons, 1934.

Plates, portfolios, colorplates, plans, and diagrams covering 50 years of the cooperative permanent building society. 1884–1934.

Manual of face-brick construction. Chicago, Ill., American Face Brick Association, 1922.

A treatise on the use of facebrick in building construction with illustrated plans, designs, and specifications.

Mason, A. A test of dry press-brick in Iowa. B. Murphy, State printer. 1904. Illustrations and diagrams.

McArdle, M. P. Brick-scale tables. St. Louis, Mo., Hydraulic Press Brick Co.

Scales and tables show the preparation of working drawing in ornamental bond and opening up new and higher possibilities in the artistic treatment of brickwork.

McBurney, J. W. The compressive and transverse strength of brick. Research Paper No. 59. Reprint from Bureau of Standards Journal of Research, April, 1929. Vol. II.

A small pamphlet.

McCarthy, Charles; Swan, Flora; *and* **McMullen, Jennie W.** Elementary civics. New York, 30 Irving Place, Thompson, Brown & Co., 1916.

McGarvey, G. A. Stone setting: the setting of cut-stone trim in brick buildings. Vocational Education Bulletin No. 106 of the U. S. Office of Education; Washington, D. C., U. S. Government Printing Office, Superintendent of Documents, 1937.

McNamara, Edward P. Ceramics. Clay Products and White Wares. Vol. III. 524 pp. illustrated. State College, Pa., The Pennsylvania State College., 1939.

One of a series of three text books covering the subject of ceramics.

Middleton, George A. T. Building materials, their nature, properties, and manufacture. New York, 23 Warren Street, William T. Comstock Co., 1905.

Miller, T. A. H. Adobe or sun-dried brick on the farm. Issued by U. S. Department of Agriculture. Washington, D. C., U. S. Government Printing Office, 1934.

Mills, Adelbert P. Materials of construction. 4th ed. ed. by Harrison W. Hayward. 423 pp. illustrated. New York, John Wiley & Sons, Inc., 1931.

Mitchell, Charles F., *and* **Mitchell, George A.** Building construction. 9th edition. revised and enlarged. 2 parts. illustrated. New York, D. Van Nostrand Co., 1919.

A textbook on the principles and details of modern construction for the use of students and practical men.

Mulligan, John A. (compiler) Brick masonry construction. 170 pp. illustrated. By John A. Mulligan. New York, 2692 Creston Avenue, 1931. Estimating data.

Munby, Alan E. Introduction to the chemistry and physics of building materials. Illustrated. (Van Nostrand's Westminster series.) New York, D. Van Nostrand Co., 1909.

National Paving Brick Manufacturers Association. The status of carbon, iron, and sulphur in clays during the various stages of burning. Indianapolis, Ind., T. A. Randall & Co., 1908.

Third Report of Committee on Technical Investigation. "A chemical study designed to shed light upon the behavior of impurities of clay."

Nichols, Edward. Building superintendence. Illustrated. Chicago, Ill., American School of Correspondence, 1920.
A working guide of the requirements of the modern construction practice; for frame, brick, and stone structures.

Orton, Edward Jr., *and* **Peppell, S. V.** Geological survey of Ohio. Bulletin No. 4. Columbus, Ohio, Ohio State University.

Orton, Edward, *Jr.* Some observations on the qualities of paving brick. Columbus, Ohio, Ohio State University, 1911. Bulletin No. 1, vol. 16, No. 3.
Result of tests on paving bricks showing 25 tables.

Palmer, L. A., *and* **Parsons, D. A.** A study of the properties of mortars and bricks and their relation to bond. No. 5, pp. 609–644, inclusive. Washington, D. C., U. S. Bureau of Standards, May 1934.

Palmer, L. A. Causes and prevention of kiln and dry-house scum and efflorescence on face-brick walls. Washington, D. C., U. S. Bureau of Standards, U. S. Government Printing Office, 1929.

Palmer, L. A. Some absorption qualities of clay brick. Washington, D. C., U. S. Bureau of Standards, U. S. Government Printing Office, 1929.

Palmer, L. A. Volume changes in brick and mortar matter. Washington, D. C., U. S. Bureau of Standards, U. S. Government Printing Office, 1931.

Palmer, L. A. Volume changes in brick masonry material. Vol. 6, Pages 1003–1026, inclusive. Journal of Research, Bureau of Standards, Washington, D. C. U. S. Government Printing Office, June 1931.
Tables and diagrams.

Peppell, S. V. The manufacture of artificial sandstone and sand-lime brick. Springfield, Ohio, Springfield Publishing Co., 1905.
Illustrations and diagrams.

Phillips, Alfred E., *and* **Byrne, Austin T.,** Masonry construction. Chicago, Ill. Drexel Avenue and Fifty-eighth Street, American School of Correspondence, 1908.

Pite, Arthur Beresford, *and others.* Building construction, 2 volumes, Volume 1 (Architect's Library). New York, 55 Fifth Avenue, Longmans, Green & Co., 1910.

Plain facts that every public official should know about sewer construction. Clay Products Association. 1935.
An 84-page loose-leaf booklet on sewer pipe. American Society for Testing Materials specifications, pages 22–33.

Plummer, Harry C., *and* **Reardon, Leslie J.** Principles of brick engineering. 400 pp. illustrations and tables. Washington, D. C., Structural Clay Products Institute, 1939.
A treatise on the use of brick in building construction and engineering products.

Purdy, Ross. Qualities of clays suitable for making paving brick. Illustrated. Urbana, Ill., Illinois State Geological Survey, 1908.
Pyrophysical and chemical properties of paving-brick clays.

Radford, William A. Radford's estimating and contracting. Chicago, Ill., 1827 Prairie Avenue, Radford Architectural Co., 1913.
A practical manual of calculating costs for all types of building construction.

Radford, William A. Types of modern brick houses and how to build them. 219 pp. illustrated. Chicago, Ill., 1827 Prairie Avenue, Radford Architectural Co., 1912.
Designs and illustrations of houses, flats, apartments, stores, and garages.

Recommended minimum requirements for small-dwelling construction. Washington, D. C., U. S. Government Printing Office, Superintendent of Documents.
A report of the building code committee of the Department of Commerce.

Richards, *Mrs.* Ellen. Sanitation in daily life, 2d ed. Boston, Mass., 30 Huntington Avenue, Whitecomb & Barrows, 1907.

Richards, H. W. Bricklaying and brickcutting. London, Longmans, Green & Co., 1901.

Richardson, W. D. Burning brick in down-draft kilns. Indianapolis, Ind., T. A. Randall & Co., 1905.

Richey, Harry G. Building mechanics' ready reference. Stone and brick masons' ed. Pt. 2. New York, 432 Fourth Avenue, John Wiley & Sons, 1907.

Ridgely, Helen West. Old brick churches of Maryland. Illustrated by Sophie De Butts Stewart. A. D. F. Randolph & Co., 1894.

Ries, Heinrich. Building stones and clay products. New York, 432 Fourth Avenue, John Wiley & Sons, 1912.
A handbook for architects.

Rogers, A. D. A house of brick for ten thousand dollars, 2d ed. Illustrations and plans. Boston, Mass., Rogers & Manson Co., 1910.

Rolfe, C. W. Clays tested which are suitable for use in the manufacture of paving brick. Urbana, Ill., Illinois State Geological Survey, 1908.

Sadler, William S. The science of living; or the art of keeping well. Rev. ed., illustrated. Chicago, Ill., 330–352 East Ohio Street, A. C. McClurg & Co., 1910.

Scrimshaw, Stewart. Bricklaying in modern practice. New York, Macmillan Co., 1920.
Illustrations and diagrams. A practical test for apprentice bricklayers.

Searle, A. B. Bricks and artificial stones of nonplastic material, their manufacture and use. Illustrated. London, J. A. Churchill, 1915.

Searle, A. B. Cements, concrete and bricks. 425 pp. illustrated. (Outlines of industrial chemistry.) New York, D. Van Nostrand Co., 1914.

Searle, A. B. Clays and clay products. 163 pp., illustrated, (Pitman's common commodities of commerce.) New York, Pitman & Sons, 1916.

Searle, A. B. Encylcopedia of the ceramic industries. 3 volumes, illustrated. London, Ernest Benn, Ltd., 1929.
A guide to the materials, method of manufacture, means of recognition, and testing the various articles produced in the clayworking and allied industries.

Searle, A. B. The glazers book. 2d ed. rev. and enl. 156 pp. London, Technical Press, 1935.
The practical application of recipes and processes to glazes for bricks and tiles.

Seaton, S. C. Brick manufacture and bricklaying. Pittsburgh, Pa., The Carnegie Library, 1912.
A collection of magazine and book articles on bricklaying and manufacture.

Seger, Herman August. Seger's collected works. Chicago, Ill., Kinfield Publishing Co., 1906.
Report of articles published on brick and chosen as being especially helpful to clayworkers.

Shank, J. R., *and* Foster, H. D. Strength of brick and tile pilasters under varied eccentric loading. 51 pp., illustrated. Columbus, Ohio, Ohio State University, 1930. Engineering experiment station bulletin No. 57.
An investigation in cooperation with the Structual Clay Tile Association.

Small Brick Houses. Architects Small House Service Bureau, Atlantic Division, Architectural Record Publishing Company, New York.

Smith, Albert. Glazed bricks, tiles, and pottery. 39 pp. Copyright in the Commonwealth of Australia, 1918.

Smith, H. Llewellyn, Barnes, George N., *and* **Davenport, F. R.** Merchandising Marks Act of 1926. His Majesty's Stationery Office, London, 1936.
Report of the standing committee respecting brick, tiles, and refractory brick and their marks of origin.

Spalding, F. P. Masonry structures. 2d ed. rev. and enlarged by A. Lincoln Hyde and Ernest F. Robinson. 586 pp. illustrated. New York, John Wiley & Sons, 1926.

Specifications and directions on construction of hollow-wall brick cottages. Chicago, Ill., J. D. Felthousen. 1883.

Standard specifications for cut Indiana limestone. Bedford, Ind. Indiana Limestone Quarrymen's Association.

Stang, A. H.; Parsons, D. E.; *and* **McBurney, J. W.** Compressive strength of clay and brick walls. Washington, D. C. Journal of Research, U. S. Bureau of Standards. 1929.

——— A portable apparatus for transverse tests of brick. English Bureau of Standards. 1927.

Stoddard, Ralph P., *and* **Lent, Leon B.** Brick structures. 95 pp. illustrated. Cleveland, Ohio. Taylor, Rogers and Bliss, Inc., and Common Brick Manufacturers Association of America. 1931.
How to build, maintain, design, construct, and plan brick houses. Written for the builder, architect, engineer, and student.

Story of brick, The. 4th ed. illustrated. Chicago, Ill. American Face Brick Association. 1926.
The permanence, beauty, and economy of brick. A brief history of its manufacture and use

Strack, H. Brick architecture of the middle ages and Renaissance in Italy. Folio, 46 p. illustrated. New York, Heburn. 1910.

Street, George Edmund. Brick and marble in the middle ages. London, J. Murry. 1855.
A tour and description of the brick and marble architecture of northern Italy.

Sweet's Catalog Service (Inc.). Sweet's catalog; architects' and builders' ed. New York, 119 West Fortieth Street, F. W. Dodge Corporation. Annual.

System of uniform cost finding for paving brick manufacturers, A. Cleveland, Ohio. National Paving Brick Manufacturers Association. 1921.
Statistics and tables.

Talbot, A. N. Qualities of high grade paving brick and tests. Illustrations. Urbana, Ill. Illinois State Geological Survey. 1908.

Tapestry brick fireplaces. Illustrations and diagrams. Boston and New York, Fiske & Co. 1914.

Tests of brick. Salt Lake City, Utah. State School of Mines, University of Utah. 1908.

Townsend, Gilbert; Dalzall, Ralph J.; McKinney, James; *and* **Dunlop, Carl H.** How to estimate. 630 pp., illustrations and blue prints. Chicago, Ill. American Technical Society. 1939.
Information and directions on estimating quantities and costs of building construction.

Twelvetrees, Walter N., *ed.* Rivington's notes on building construction. New ed. illustrated. 2 parts. New York. Longmans, Green & Co. 1915.
A book of references for architects and builders, and a text-book for students.

Types of modern brick houses. Indianapolis, Ind. National Building Brick Bureau. 1917.

A collection of 12 brick houses (6 to 8 rooms) and their floor plans.

U. S. Bureau of Mines. The burning problem of industrial kilns. Washington, D. C. U. S. Government Printing Office. 1920.

An investigation by the Ceramics Experiment Station and Fuel Division of the U. S. Bureau of Mines.

U. S. Government master specifications for brick, clay, common. Federal Specifications Board. No. 504. Washington, D. C. U. S. Government Printing Office. 1927.

Van Tassel, Alfred J., *and* **Bluestone, David W.** Mechanization in the brick industry. 83 pp. illustrated. Washington, D. C. Works Progress Administration. 1939.

Method of manufacturing brick previous to 1920 and improvements which have been made since that date.

Vaugh, Mason. Reinforced brickwork. 84 pp. illustrated Bulletin, vol. 29, No. 37; Engineering experiment station, series 28; Columbia, Mo., University of Missouri. 1928.

Vitrified brick for street pavement. Eastern Paving Brick Co. 1899.

Wallace, W. W. Brick pavements. Clay Publishing Co. 1885.

Warland, E. G. Modern practical masonry. 253 pp. illustrations and tables. New York, Dodd Mead & Co. 1929.

A treatise on masonry construction and methods of cutting stone, with drawings showing layouts.

Webb, Walter L., *and* **Gibson, Herbert.** Masonry and reinforced concrete. Chicago, Ill. American School of Correspondence. 1909.

Weller, H. O. Sand, lime and other concrete bricks. London. His Majesty's Stationery Office. 1921.

A scientific research on sand, lime-brick and brickmaking.

West, Miriam B. Productivity and employment in the brick and tile industry. 212 pp. illustrated. Washington, D. C. Works Progress Administration. 1939.

History of the production of brick and tile from 1849–1936 pointing out the changes in the process of manufacturing clay products.

Wheeler, H. A. Vitrified paving brick. 2d ed. Indianapolis, Ind., T. A. Randall & Co. 1910.

"Why" of block and tackle. Emergency Conservation Work, Project Training, series No. 1. Washington, D. C., National Park Service.

Mimeographed pamphlet with diagrams giving a simple presentation of the mechanics of block and tackle.

Williamson, H. Duff. Reinforced brickwork. New York. Rensselaer Polytechnic Institute. 1934. (Engineering and Science Series.)

Your Next Home. Cleveland, Ohio. Collected by the Common Brick Manufacturers Association. 1925.

Illustrated with diagrams and photos.

Zaiman, A., *and* **MacIntyre, W. A.** Economic and manufacturing aspects of the building brick industries. London, Harrison & Sons. 1933.

Illustrated with maps, tables, and diagrams.

Appendix E.—ASSOCIATIONS AND ORGANIZATIONS CONCERNED WITH BRICKLAYING

National Lime Association, 927 15th Street, NW., Washington, D. C.

Portland Cement Association, 33 W. Grand Avenue, Chicago, Ill.

National Terra Cotta Manufacturers Association, 2 W. 45th Street, New York, N. Y.

Bricklayers, Masons, and Plasterers' International Union, Bowen Building, Washington, D. C.

Associated General Contractors of America, Munsey Building, Washington, D. C.

Mason Contractors of the United States and Canada, Munsey Building, Washington, D. C.

National Paving Brick Association, 1245 National Press Building, Washington, D. C.

Structural Clay Products Institute, 1427 I Street NW., Washington, D. C.

American Institute of Architects, Octagon Building, 1741 New York Avenue NW., Washington, D. C.

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